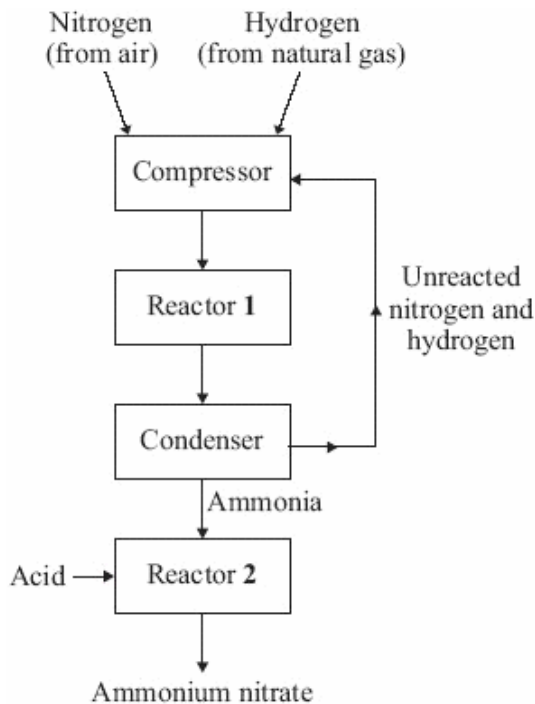


**Making ammonia**

1. 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.

- (a) The compressor increases the 

pressure
temperature
volume

 to 200 atmospheres. (1)

- (b) In reactor 1 ammonia is made by reacting 

air
natural gas
nitrogen

 with 

air.
hydrogen.
natural gas.

(2)

- (c) In the condenser the mixture is 

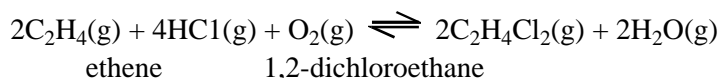
cooled
heated
reduced

 and the ammonia is separated as a liquid.

(1)  
(Total 4 marks)

2. The monomer chloroethene is made from ethene in a two-stage process,

(a) The first stage is to convert ethene to 1,2-dichloroethane.



State and explain the effect of increasing the pressure on:

(i) the yield of 1,2-dichloroethane;

.....  
.....

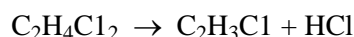
(2)

(ii) the rate of reaction.

.....  
.....

(2)

(b) In the second stage 1,2-dichloroethane is converted into chloroethene.



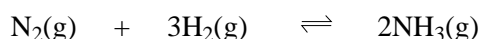
This reaction is a thermal decomposition.

Suggest what would need to be done to decompose 1,2-dichloroethane.

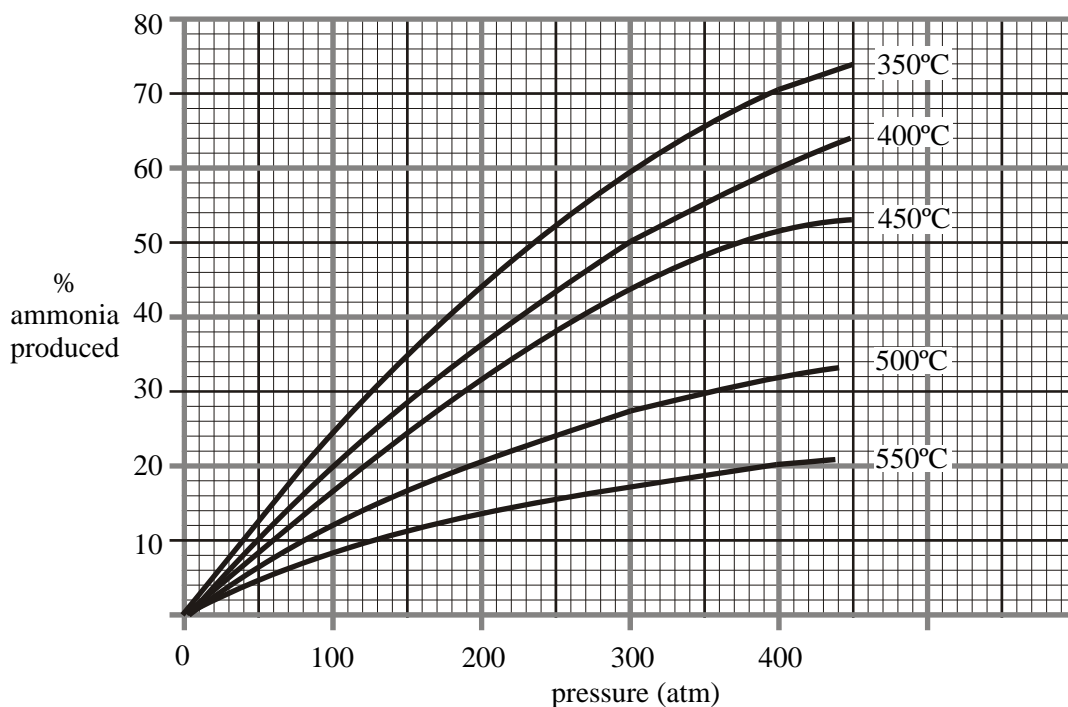
.....  
.....

(1)  
(Total 5 marks)

3. Ammonia is produced by the Haber process. In the process nitrogen and hydrogen are mixed. The pressure is increased to about 200 atmospheres. The gases are passed over an iron catalyst at about 450°C. The equation for the reaction is:



The reaction between nitrogen and hydrogen is reversible. This affects the amount of ammonia that it is possible to obtain from the process. The graph below shows how the pressure and temperature affect the percentage of ammonia that can be produced.



Use this information, together with your knowledge of the process, to explain why many industrial ammonia plants operate at 200 atmospheres and 450°C.

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(Total 5 marks)