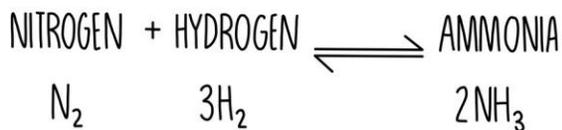


## Haber Process (manufacturing of Ammonia)



Nitrogen and hydrogen gas are mixed in the ratio of **1 mole of nitrogen and 3 of hydrogen**

### Nitrogen:

Nitrogen is obtained by fractional distillation of liquified air.

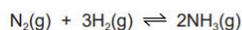
### Hydrogen:

- Hydrogen is obtained by cracking of crude oil(petroleum) to give an alkene and hydrogen .
- This comes from **methane gas** by reacting it with **steam** at a temp of **750°C** and using **nickel catalyst**.



**Carbon monoxide produced reacts with more steam to form more hydrogen and carbon dioxide gas.**

Ammonia is manufactured by the Haber process.



The forward reaction is exothermic.

(a) Describe how the reactants are obtained.

(i) Nitrogen

.....  
 ..... [2]

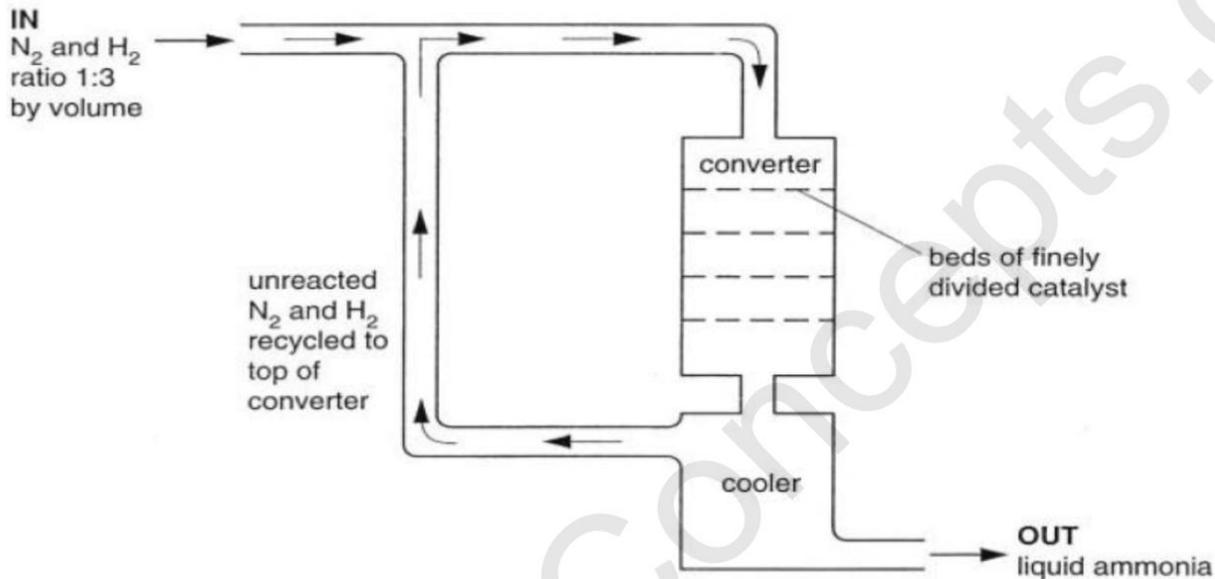
(ii) Hydrogen

.....  
 .....  
 ..... [3]

- (a) (i) fractional distillation (liquid) air [1]  
 [1]
- (ii) cracking / heat in presence of catalyst of alkane / petroleum to give an alkene and hydrogen [1]  
 [1]  
 [1]

**OR:** electrolysis (1)  
 named electrolyte (1)  
 hydrogen at cathode (1)

**OR:** from methane (1)  
 react water / steam (1)  
 heat catalyst (1)  
 only **ACCEPT:** water with methane or electrolysis



Lowering the temperature **decreases the rate of reaction** but **increases the yield of ammonia** as equilibrium position moves in the **exothermic direction**.

Increasing the temp **increases the rate of reaction** but **decreases the yield of ammonia** as equilibrium position moves in the **endothermic direction**.

Decreasing the pressure **decreases the rate of reaction and decreases the yield of ammonia** as equilibrium position moves to the direction that has **more gas mole**.

Increasing the pressure **increases the rate of reaction and increases the yield of ammonia** as equilibrium moves to the side that has **less gas mole**.  
(but at a higher cost)

Less temperature favours the exothermic reaction but low temperature decreases the rate of reaction.

More high pressure can give more yield but applying high pressure is costly because strong pipes are required.

So for Habers process compromise temprature and pressure used.

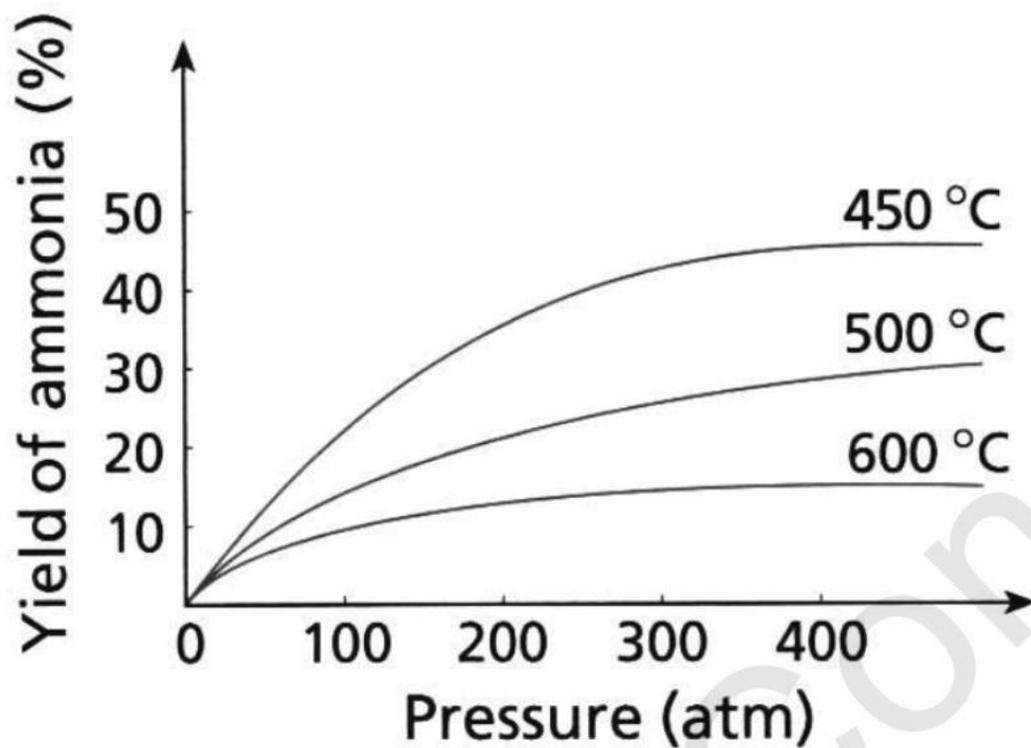
### Conditions for haber process

**Temp: 450°C**

**pressure of 200 atmospheric pressure/20000 kilo pascal**

**iron as a catalyst**

After passing over the catalyst mixture contain ammonia ,nitrogen and hydrogen. Hydrogen and nitrogen sent over the catalyst again to make more ammonia. Ammonia is the only gas condensed and liquified as it has higher boiling point than hydrogen and nitrogen.



#### Uses of ammonia:

It is use in making of fertilizers.  
It is use in making of nitric acid.