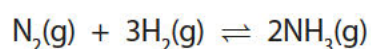


- 1 When nitrogen and hydrogen react to form ammonia, the reaction can reach a dynamic equilibrium.



- (a) Explain what is meant by a **dynamic equilibrium**.

(2)

- (b) In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

- (i) The pressure used is 250 atmospheres.

Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

- (ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic. The temperature used is 450 °C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

(iii) Even at 450 °C, the reaction is very slow.

State what is used in industry to overcome this problem.

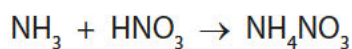
(1)

(c) (i) Calculate the minimum volume of hydrogen required to completely convert 1000 dm³ of nitrogen into ammonia.

(1)

volume of hydrogen = dm³

(ii) Ammonia is reacted with excess nitric acid, HNO₃, to make ammonium nitrate, NH₄NO₃.



Calculate the mass of ammonium nitrate produced by the complete reaction of 34 g of ammonia.

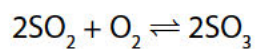
(Relative atomic masses H = 1.0, N = 14, O = 16)

(3)

mass of ammonium nitrate produced = g

(Total for Question 1 = 11 marks)

2 Sulfur trioxide is produced by reacting sulfur dioxide with oxygen.



- (a) (i) This reaction takes place in industry at 1–2 atm pressure and can reach a dynamic equilibrium.

Explain the effect on the rate of attainment of equilibrium, if the process is carried out at a pressure higher than 1–2 atm.

(3)

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- (ii) What volume of oxygen, in cm^3 , would react completely with 500 cm^3 sulfur dioxide?

(1)

- A 500
- B 500
- C 500
- D 500

- (b) When there are alternative methods of producing a product, the final pathway is chosen by considering atom economy, cost of energy, yield of product and rates of reactions.

State another factor that should also be considered.

(1)

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