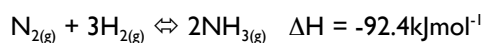


Chemical Monitoring and Management

- How can atomic absorption spectroscopy be used in the detection of pollution?
 - To analyse concentrations of metals in a solution
 - To determine organic contamination in a water supply
 - To analyse concentrations of non-metals in solution
 - To analyse pH of a water supply
- Which of the following is not an industrial use of ammonia?
 - Fertiliser production
 - Production of cleaning agents
 - Manufacture of explosives
 - Ethanol production
- In which zone or layer of the Earth's atmosphere is the highest concentration of ozone found?
 - Troposphere
 - Stratosphere
 - Above the stratosphere
 - At the boundary between the stratosphere and the troposphere
- What would a catalyst do in the production of ammonia?
 - Increase the activation energy
 - Decrease the activation energy
 - Increase the yield of ammonia
 - Decrease the yield of ammonia

- Describe the conditions under which Haber developed the industrial synthesis of ammonia and evaluate the significance of the development of the Haber process at that time in history. (6 marks)

- The following is an equation for the production of ammonia:



- Define Le Chatelier's principle (1 mark)
- The Haber process is an industrial process used to produce ammonia from nitrogen and hydrogen gas
 - Outline under what conditions ammonia is produced using the Haber process (2 marks)
 - Explain using Le Chatelier's principle one trade-off used in the Haber process to achieve the most yield for the least cost (2 marks)

1. A
2. D
3. B
4. B
5. Haber developed his process for the production of ammonia in Germany when the German government was preparing for World War I. Ammonia is a main reactant in the production of nitrogen compounds used for explosives. At this time there was also a shortage of fertilisers, because the main stocks came from South America and were expensive as well as taking a significantly long time to arrive in Europe.

Haber and other chemists knew that the development of a process to convert atmospheric nitrogen to a useable product would be advantageous, especially in terms of cost, for industry and farming.

By 1913, Haber had developed a method of reacting atmospheric nitrogen with hydrogen gas in the presence of an iron catalyst that produced ammonia. This reaction allowed the German army to use ammonia to make the nitrogen compound necessary for explosives. As a result of this, World War I was perhaps lengthened, as the Germans still had ready access to nitrogen compounds without needing to ship them from South America through war-torn seas.

6.
 - (a) If a system at equilibrium is disturbed, then the system adjusts itself so as to minimise the change.
 - (b)
 - (i) Conditions of the Haber process:
 - A pressure of about 35 MPa
 - Use of a catalyst – iron
 - Temperature of 400 to 500 °C
 - The ammonia is liquefied to separate it
 - Unreacted gases are sent around again for further reaction
 - (ii) A trade-off is met with the temperature, which is moderate, to allow for an increase in the reaction rate so that equilibrium is achieved more quickly. According to Le Chatelier's principle, the above equilibrium would be forced to the production of ammonia, at low temperatures, as the reaction is exothermic.