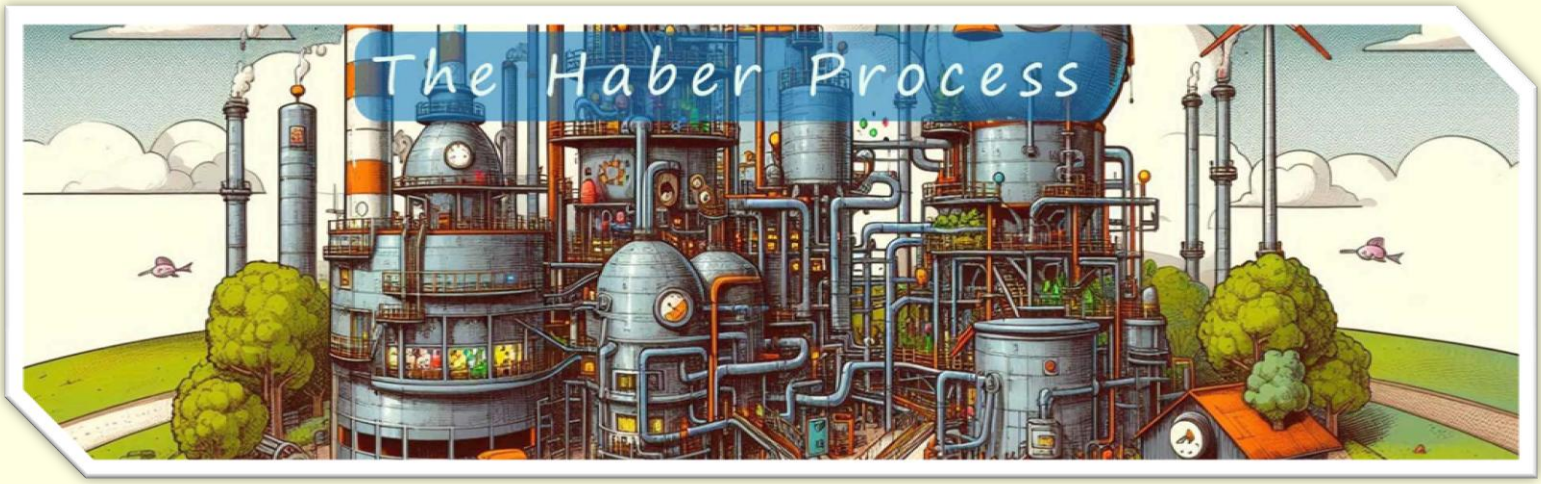


Answer the questions below then check your answers

1. What is the molecular formula of ammonia?

a) NH_2 b) NH_3 c) NH_4 d) N_2H_4

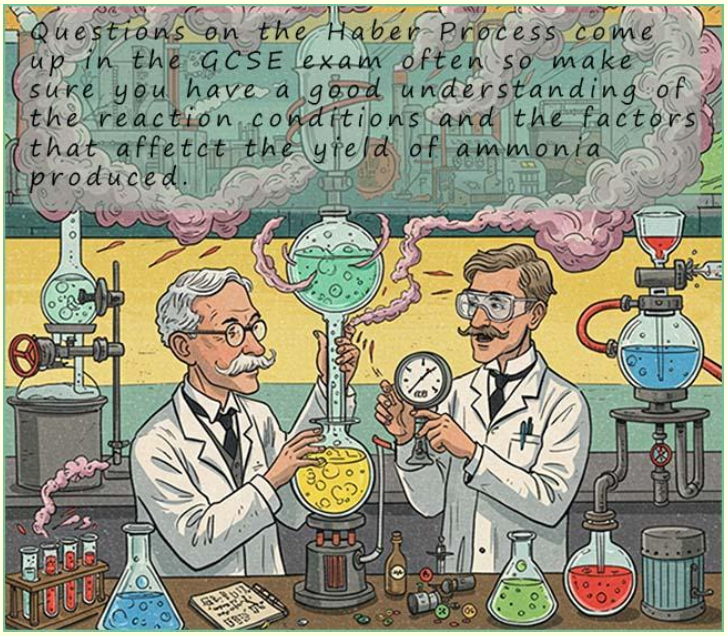
2. Name two uses of ammonia.

3. True or False: The Haber-Bosch process was developed by one scientist.

Fill in the Blanks to complete the sentence below:

4. Ammonia dissolves in water to form the weak alkali

_____.



5. Where does the nitrogen gas used in the Haber process come from?

6. where does the hydrogen needed for the Haber process come from?

7. Put the following steps of the Haber process in the correct order:

a) Ammonia is cooled and liquefied.

b) Nitrogen and hydrogen are mixed in a 1:3 ratio.

c) Gases are passed over an iron catalyst at high temperature and pressure.

d) Unreacted gases are recycled.

8. Why is a catalyst used in the Haber process?

9. The forward reaction in the Haber process is exothermic. How does increasing the temperature affect the yield of ammonia? Explain your answer using Le Chatelier's principle.

10. The Haber process operates at a compromise temperature of around 450°C. Explain why a low temperature is not used, even though it would favour a higher yield of ammonia.

11. Explain how increasing the pressure affects the yield of ammonia in the Haber process, using Le Chatelier's principle. Also, discuss the economic and safety considerations of using very high pressures.

12. Problem Solving: If a chemical plant was aiming to produce ammonia at the highest possible rate, what conditions would they choose, and why might these not be the conditions used in practice?

13. Comparing and Contrasting: Explain the difference between the effect of a catalyst on the rate of reaction and its effect on the position of equilibrium.

Answers

1. What is the molecular formula of ammonia?

a) NH_2 b) NH_3 c) NH_4 d) N_2H_4

Answer: b) NH_3

2. Name two uses of ammonia.

Answer: Fertilisers and explosives (or ammonium nitrate production).

3. True or False: The Haber-Bosch process was developed by one scientist.

Answer: False (It was developed by Fritz Haber and Carl Bosch).

Fill in the Blanks to complete the sentence below:

4. Ammonia dissolves in water to form the weak alkali _____.

Answer: ammonium hydroxide

5. Where does the nitrogen gas used in the Haber process come from?

Answer: The air (approximately 78% nitrogen).

6. where doe sthe hydrogen needed for the Haber process come from?

Answer: reaction of Methane/Natural Gas and Steam

7. Put the following steps of the Haber process in the correct order:

a) Ammonia is cooled and liquefied.

b) Nitrogen and hydrogen are mixed in a 1:3 ratio.

c) Gases are passed over an iron catalyst at high temperature and pressure.

d) Unreacted gases are recycled.

Answer: b, c, a, d

8. Why is a catalyst used in the Haber process?

Answer: To speed up the reaction rate by lowering the activation energy.

9. The forward reaction in the Haber process is exothermic. How does increasing the temperature affect the yield of ammonia? Explain your answer using Le Chatelier's principle.

Answer: Increasing the temperature will shift the equilibrium to the left (the endothermic direction), decreasing the yield of ammonia. This is because the system will try to counteract the increase in temperature by favouring the reaction that absorbs heat.

10. The Haber process operates at a compromise temperature of around 450°C. Explain why a low temperature is not used, even though it would favour a higher yield of ammonia.

Answer: A low temperature would significantly slow down the rate of reaction, making the process too slow to be economically viable. The catalyst also works most efficiently at higher temperatures. A compromise temperature is used to balance yield and rate.

11. Explain how increasing the pressure affects the yield of ammonia in the Haber process, using Le Chatelier's principle. Also, discuss the economic and safety considerations of using very high pressures.

Answer: Increasing the pressure shifts the equilibrium to the side with fewer moles of gas (the product side, 2 moles of NH_3). This increases the yield of ammonia. However, very high pressures are expensive to maintain (requiring strong equipment and high energy input) and increase the risk of explosions, making it necessary to use a compromise pressure.

12. Problem Solving: If a chemical plant was aiming to produce ammonia at the highest possible rate, what conditions would they choose, and why might these not be the conditions used in practice?

Answer: They would choose a very high temperature and pressure, along with a catalyst. This would maximise the rate of reaction. However, extremely high temperatures reduce the yield of ammonia, and very high pressures are expensive and dangerous, thus compromise conditions are used in practice.

13. Comparing and Contrasting: Explain the difference between the effect of a catalyst on the rate of reaction and its effect on the position of equilibrium.

Answer: A catalyst speeds up the rate of both the forward and reverse reactions equally, therefore it does not change the position of equilibrium. It only helps the equilibrium to be reached faster.