

Answer the questions below then check your answers

1. Which of the following is the catalyst used in the Ostwald process?

- a) Iron b) Vanadium(V) oxide c) Platinum/Rhodium d) Nickel

2. What gas is produced when ammonia is burned in oxygen *without* a catalyst?

- a) Nitrogen monoxide (NO) b) Nitrogen dioxide (NO₂)

- c) Nitrogen (N₂) d) Nitric acid (HNO₃)

3. Which of the following non-metal oxides dissolves in water to form nitric acid?

- a) Carbon dioxide b) Sulfur trioxide

- c) Nitrogen dioxide d) Sulfur dioxide

3. Write the balanced symbol equation for the reaction between ammonia and oxygen in the presence of a platinum catalyst.

4. Explain why simply burning nitrogen gas in air is not a practical method for producing nitrogen dioxide.
5. Describe what happens to nitrogen monoxide (NO) when it is exposed to air.
6. The Ostwald process is used to produce nitric acid on a large scale. Briefly outline the three main stages of the Ostwald process. Explain why the reaction between ammonia and oxygen in the reactor is described as exothermic. Suggest one way in which the heat energy released in the reactor could be used in the Ostwald process.
7. Ammonium nitrate (NH_4NO_3) is a common fertiliser. Write the word equation for the reaction between ammonium hydroxide and nitric acid to produce ammonium nitrate. Explain why this reaction is called a neutralisation reaction. State one advantage of using ammonium nitrate as a fertiliser.
8. The Haber process and the Ostwald process are linked in the industrial production of fertilisers. Explain how these two processes are linked and discuss the importance of these processes to modern agriculture.

Answers

1. Which of the following is the catalyst used in the Ostwald process?

- a) Iron b) Vanadium(V) oxide c) Platinum/Rhodium d) Nickel

Answer: c) Platinum/Rhodium

2. What gas is produced when ammonia is burned in oxygen **without** a catalyst?

- a) Nitrogen monoxide (NO) b) Nitrogen dioxide (NO₂)
c) Nitrogen (N₂) d) Nitric acid (HNO₃)

Answer: c) Nitrogen (N₂)

3. Which of the following non-metal oxides dissolves in water to form nitric acid?

- a) Carbon dioxide b) Sulfur trioxide
c) Nitrogen dioxide d) Sulfur dioxide

Answer: c) Nitrogen dioxide

3. Write the balanced symbol equation for the reaction between ammonia and oxygen in the presence of a platinum catalyst.

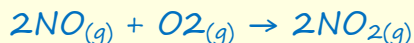


4. Explain why simply burning nitrogen gas in air is not a practical method for producing nitrogen dioxide.

Answer: Nitrogen gas is very unreactive due to the strong triple bond between the nitrogen atoms. Therefore, it does not readily react with oxygen in the air under normal conditions.

5. Describe what happens to nitrogen monoxide (NO) when it is exposed to air.

Answer: Nitrogen monoxide reacts with oxygen in the air to form nitrogen dioxide



6. The Ostwald process is used to produce nitric acid on a large scale. Briefly outline the three main stages of the Ostwald process. Explain why the reaction between ammonia and oxygen in the reactor is described as exothermic. Suggest one way in which the heat energy released in the reactor could be used in the Ostwald process.

Answer:

- Ammonia is reacted with oxygen in the presence of a platinum catalyst to form nitrogen monoxide and water.
- Nitrogen monoxide reacts with oxygen to form nitrogen dioxide.
- Nitrogen dioxide is dissolved in water (with excess air) to form nitric acid.
- The reaction releases a large amount of heat energy.
- To pre-heat the incoming gases (oxygen and ammonia) or to generate electricity.

7. Ammonium nitrate (NH_4NO_3) is a common fertiliser. Write the word equation for the reaction between ammonium hydroxide and nitric acid to produce ammonium nitrate. Explain why this reaction is called a neutralisation reaction. State one advantage of using ammonium nitrate as a fertiliser.

Answer:

Ammonium hydroxide + Nitric acid \rightarrow Ammonium nitrate + Water

It's a reaction between an acid (nitric acid) and a base (ammonium hydroxide) which produces a salt (ammonium nitrate) and water.

It contains two sources of nitrogen, which is an essential nutrient for plant growth. (Or similar valid point)

8. The Haber process and the Ostwald process are linked in the industrial production of fertilisers. Explain how these two processes are linked and discuss the importance of these processes to modern agriculture.

Answer: The Haber process produces ammonia, which is a crucial reactant in the Ostwald process for making nitric acid. The nitric acid produced by the Ostwald process is then used to make ammonium nitrate, a common nitrogen-based fertiliser. These processes are vital for modern agriculture because they enable the large-scale production of nitrogen fertilisers, which are essential for increasing crop yields to feed the growing global population. Without these industrial processes, it would be extremely difficult to produce enough food to meet the current demand.