

Haber Process Fertilisers

GCSE Chemistry · Written to the shared content for AQA, Edexcel and OCR

Name _____ Class _____ Date _____

1. Worked example

Describe the Haber process. (4 marks)

Step 1 · Raw materials

Nitrogen from the air; hydrogen from natural gas (methane).

Step 2 · Conditions

The gases are passed over an iron catalyst at about 450 °C and 200 atmospheres pressure.

Step 3 · Reaction

$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ (reversible).

Step 4 · Separation

The mixture is cooled; ammonia liquefies and is removed; unreacted nitrogen and hydrogen are recycled.

Answer: $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ over iron at 450 °C and 200 atm; cool, remove NH_3 , recycle gases

Check: Recycling means almost all of the starting gases are eventually converted.

2. Now try one with the steps

**Calculate the percentage by mass of nitrogen in ammonium nitrate, NH_4NO_3 . (N = 14, H = 1, O = 16)
(2 marks)**

Step 1 · M_r

Step 2 · Percentage

Answer:

3. Practice

Show your working. The marks tell you how much is expected.

1. Name the raw materials for nitrogen and hydrogen in the Haber process. [2]

2. State the conditions used in the Haber process. [3]

3. Write the balanced equation for the Haber process. [1]
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4. Describe how ammonia is separated from the reaction mixture. [1]
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5. State what happens to the unreacted nitrogen and hydrogen. [1]
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6. Name the three elements supplied by NPK fertilisers. [1]
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7. Explain why farmers use fertilisers. [1]
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8. Name the salt formed when ammonia reacts with nitric acid. [1]
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9. Calculate the percentage by mass of nitrogen in ammonium nitrate, NH_4NO_3 . (N = 14, H = 1, O = 16) [2]
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10. Calculate the percentage by mass of nitrogen in ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, to 3 significant figures. (N = 14, H = 1, S = 32, O = 16) [2]
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11. State how potassium compounds for fertilisers are obtained. [1]
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12. Describe how phosphate rock is made into a soluble fertiliser. [2]
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13. Explain why a pressure of about 200 atmospheres is used, rather than a much higher pressure. [3]

14. Calculate the maximum mass, in tonnes, of ammonia made from 28 tonnes of nitrogen. $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ (N = 14, H = 1) [3]

4. Before you hand it in

"The iron catalyst increases the yield."

Iron speeds up the reaction so equilibrium is reached faster.

"Lower temperature is used because the reaction is endothermic."

Lower temperature favours the exothermic forward reaction but is too slow, so 450 °C is a compromise.

"NPK means nitrogen, phosphate, potassium compounds only from mines."

N from ammonia (Haber); P from phosphate rock with acids; K mined or K_2SO_4 .