

Chem!stry

Name: ()

Class:

Date: / /

The Properties, Preparation and Uses of Ammonia – NH₃ – Answers

Question One:

Which of the properties listed below correctly apply to ammonia gas? Place and in the appropriate boxes.

- | | | |
|-------------------------------|-------------------------------------------|--------------------------------------------|
| • Insoluble in water. | True: <input checked="" type="checkbox"/> | False: <input checked="" type="checkbox"/> |
| • Colourless. | True: <input checked="" type="checkbox"/> | False: <input checked="" type="checkbox"/> |
| • Less dense than air. | True: <input checked="" type="checkbox"/> | False: <input checked="" type="checkbox"/> |
| • Acidic. | True: <input checked="" type="checkbox"/> | False: <input checked="" type="checkbox"/> |
| • Odourless. | True: <input checked="" type="checkbox"/> | False: <input checked="" type="checkbox"/> |
| • Can neutralise acids. | True: <input checked="" type="checkbox"/> | False: <input checked="" type="checkbox"/> |
| • Turns damp red litmus blue. | True: <input checked="" type="checkbox"/> | False: <input checked="" type="checkbox"/> |

Question Two:

a) State the origin of the nitrogen gas used in the industrial manufacture of ammonia:

The nitrogen is obtained by fractional distillation of liquefied air.

b) State a possible origin of the hydrogen gas used in the industrial manufacture of ammonia:

Produced by the reaction between methane and steam / cracking long-chain hydrocarbons.

c) Write a balanced chemical equation, including state symbols, to show the formation of ammonia from nitrogen and hydrogen. Remember to indicate that the reaction is reversible:



d) What conditions are used for the industrial manufacture of ammonia?

- Temperature: 450°C
- Pressure: 200 atm.
- Catalyst: Iron – Fe

Question Three:

a) Complete the balanced chemical equation for the laboratory preparation of ammonia gas:



- b) Why is it **not** advisable to dry the ammonia gas using an acidic drying agent such as concentrated sulfuric acid? Write a balanced chemical equation to explain your answer.

Ammonia is basic. It would react with an acidic drying agent to form a salt. Consequently, it would not be possible to collect the ammonia gas. For example, drying $\text{NH}_3(\text{g})$ with $\text{H}_2\text{SO}_4(\text{aq})$:

$$2\text{NH}_3(\text{g}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow (\text{NH}_4)_2\text{SO}_4(\text{aq})$$

- c) Why is it **not** advisable to collect the ammonia gas by the downward displacement of water? Ammonia is extremely soluble in water. The gas would dissolve to form a solution. Consequently, it would not be possible to collect the ammonia gas.

- d) What property of the ammonia gas allows it to be collected in an inverted test tube? Ammonia gas is less dense than air. It will rise-up into the inverted test tube and displace the air from the test tube.

Question Four:

- a) What would you observe when ammonia gas and hydrogen chloride gas are allowed to mix together?

A white smoke of ammonium chloride would be formed.

- b) Write a balanced chemical equation to describe the reaction that is taking place in Question Four a):



Question Five:

- a) What is a fertilizer?

A chemical that contains nutrients (e.g. K, N and P) that are essential for plant growth.

- b) Write a balanced chemical equation to show how a fertilizer can be prepared from ammonia:



- c) Calculate which fertilizer contains the greatest percentage nitrogen:

- i) ammonium nitrate, NH_4NO_3 :

$$[(2 \times \text{N}) \div (\text{M}_r \text{ of } \text{NH}_4\text{NO}_3)] \times 100 = [28 \div 80] \times 100 = 35.0 \%$$

- ii) ammonium sulphate, $(\text{NH}_4)_2\text{SO}_4$:

$$[(2 \times \text{N}) \div (\text{M}_r \text{ of } (\text{NH}_4)_2\text{SO}_4)] \times 100 = [28 \div 132] \times 100 = 21.2 \%$$

- d) Why are high levels of nitrates in lakes and rivers dangerous?

The rapid growth and death of plants will remove oxygen from the water – eutrophication.

- e) Why would you advise a farmer **not** to add calcium hydroxide to a field that he has recently added ammonium nitrate fertilizer to? Write a balanced chemical equation to support your answer.

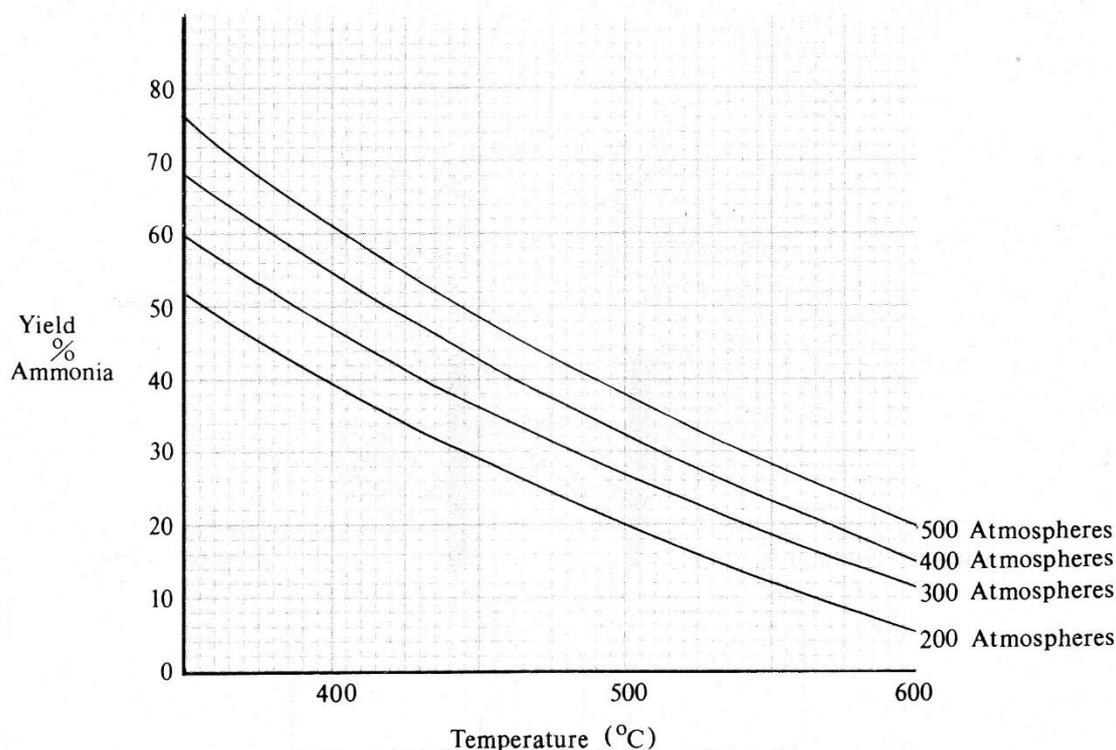
The calcium hydroxide and ammonium nitrate will react together to produce calcium nitrate, water and ammonia: $\text{Ca(OH)}_{2(\text{aq})} + 2\text{NH}_4\text{NO}_{3(\text{aq})} \rightarrow \text{Ca(NO}_3)_2(\text{aq}) + 2\text{H}_2\text{O}_{(\text{l})} + 2\text{NH}_{3(\text{g})}$.

Calcium hydroxide reacts and is removed from the soil, it cannot regulate the pH of the soil.

Ammonium nitrate reacts to form gaseous ammonia, some nitrogen is removed from the soil.

Question Six:

Between 1905 and 1915 Fritz Haber developed the process by which nitrogen and hydrogen may be combined to make ammonia. This is a difficult reaction to perform, so he had to do a great deal of work to find the correct temperature and pressure conditions for the process. Some of his measurements are shown in the graphs below:



- a) What happens to the yield of ammonia when:
- The temperature of the reaction is increased?
As the temperature increases, the yield of ammonia decreases.
 - The pressure of the reaction is increased?
As the pressure increases, the yield of ammonia increases.

- b) A new works manager has been appointed who would like to increase the yield of ammonia from the process. Suggest a reason why she should **not**...
- i) Make a large increase in the pressure at which the process operates:
Increasing the pressure will increase the yield of ammonia, however, a very high pressure is potentially dangerous as it increase the risk of ammonia leaking out of the system.
 - ii) Make a large decrease in the temperature at which the process operates:
Decreasing the temperature will increase the yield of ammonia, however, it will also decrease the speed of the reaction / decrease the rate at which the ammonia is formed.