Kjeldahl Method Chemistry Questions with Solutions

Q1. Ammonia evolved from 0.75g of sample neutralized 10ml. of 1M H_2SO_4 in Kjedahl's method for estimating nitrogen present in soil samples. The nitrogen percentage in the soil is:

a.) 37.33
b.) 445.33
c.) 35.33
d.) 43.33

Correct Answer- (a.) 37.33

Q2. Copper sulphate acts as ____ in Kjeldahl's nitrogen estimation method.

a.) Oxidizing agent
b.) Silver spiral
c.) Catalytic agent
d.) Hydrolyzing agent

Correct Answer- (c.) Catalytic agent

Q3. Kjeldahl's method is used to estimate nitrogen. For the complete neutralization of NH_3 gas, 2.8 gm of an organic compound required 20 millimoles of H_2SO_4. The nitrogen percentage in the sample is:

a.) 20%
b.) 10%
c.) 40%
d.) 30%

Correct Answer- (a.) 20%

Q4. Kjeldahl's method cannot be used for:

a.) $PhNO_2$
b.) Azobenzene
c.) Pyridine
d.) All of the above

Correct Answer- (d.) All of the above

Explanation- Kjeldahl's method cannot be used to determine nitrogen in compounds with nitro groups, azo groups, or nitrogen present in rings because the nitrogen in these compounds cannot be converted to ammonium sulphate under the conditions of this method.

Q5. Which of the following raises the boiling point of H_2SO_4 while $CuSO_4$ catalyzes the reaction.

a.) K_2SO_4
b.) Na_2SO_4
c.) $BaSO_4$
d.) All of the above

Correct Answer- (a.) K_2SO_4

Q6. What is the principle of the Kjeldahl method?

Answer. Johann Kjeldahl, a brewer, invented the Kjeldahl method in 1883. The protocol is based on the idea that strong acid aids in food digestion by releasing nitrogen, which can be measured using a suitable titration technique.

Q7. Which indicator is used in the Kjeldahl method?

Answer. The Tashiro indicator, which is added to the boric acid solution, is one of the most commonly used indicator solutions. The endpoint is represented by a grey / pink colour. The analyst manually adds the acid titrant solution to the boric acid containing distilled ammonia using a glass burette.

Q8. Why boric acid is used in the Kjeldahl method?

Answer. The ammonia gas is captured by the boric acid, resulting in the formation of an ammonium-borate complex. The colour of the receiving solutions changes as the ammonia accumulates. The boric acid method has the advantage of requiring only one standard solution for the determination and having a long shelf life.

Q9. What are the limitations of the Kjeldahl method?

Answer. Only nitrogen bound to organic components (proteins, amino acids, nucleic acids) and ammonium are measured in this method. This method is incompatible with compounds containing nitrogen in azo and nitro groups or rings (quinoline, pyridine, nitrate, nitrite, etc.).

Q10. What are the steps of the Kjeldahl method?

Answer. The Kjeldahl method consists of three major steps: digestion, distillation, and titration.

Q11. Why is the Kjeldahl method important?

Answer. For its universality, precision, and reproducibility, the Kjeldahl method has become the internationally recognized method for estimating the protein content in foods, and it serves as the standard against which all other methods are judged. It is also used in the analysis of soils, wastewaters, fertilizers, and other materials.

Q12. 29.5 mg of an organic compound containing nitrogen was digested according to Kjeldahl's method and the evolved ammonia was absorbed in 20 mL of 0.1M HCl solution. The excess of the acid required 15 mL of 0.1 M NaOH solution for complete neutralization. What will be the percentage of nitrogen in the compound?

Answer. Moles of HCl reacting with ammonia = (moles of HCl absorbed) – (moles of NaOH solution required)
= $(20 \times 0.1 \times 10^{-3}) - (15 \times 0.1 \times 10^{-3})$
= Moles of NH_3 evolved
= Moles of nitrogen in organic compound
Hence,
Weight of nitrogen in organic compound = $0.5 \times 10^{-3} \times 14$
We get,
= 7×10^{-3} g
% of nitrogen = $(7 \times 10^{-3})/(29.5 \times 10^{-3}) \times 100$
We get,
= 23.7%
Therefore, the percentage of nitrogen in the compound is 23.7%

Q13. How does the Kjeldahl Method work?

Answer. Johann Kjeldahl, a brewer, invented the Kjeldahl technique in 1883. The procedure is based on the theory that strong acid aids in food digestion by releasing nitrogen that can be measured using an accurate titration technique.
In the traditional Kjeldahl method, the proteins are 'digested' in sulfuric acid with a catalyst (selenium, mercury, or copper salts). An acid deposit of ammonium sulphate is formed, which is then dissolved in water. The excess acid is back-titrated with normal NaOH to determine the total ammonia and, thus, nitrogen.

Q14. Explain the very first step of this method.

Answer. In this method, a certain substance or sample is heated in the presence of sulphuric acid. The acid breaks down the organic substance via oxidation, and reduced nitrogen in the form of ammonium sulphate is liberated. Potassium sulphate is usually added to increase the boiling point of the medium. Catalysts like mercury, selenium, copper, or ions of mercury or copper are also used in the digestion process. The sample is fully decomposed when we obtain a clear and colorless solution.
Organic compound + $H_2SO_4 \rightarrow [digest]Cu^{2+}(NH_4)_2SO_4$

Q15. What is the point of including H_2SO_4 in the first step of the Kjeldahl method?

Answer. This method is entirely dependent on a high boiling point. The addition of salt and catalyst greatly accelerates digestion. Furthermore, adding potassium sulphate raises the boiling point of sulfuric acid even more. Finally, the catalyst's action increases the speed and efficiency of the digestion procedure, thus improving the analytical method.

Practise Questions on the Kjeldahl Method

Q1. Kjeldahl's method produced 0.17 g of NH_3 from 0.28 g of a nitrogenous compound during the estimation of nitrogen present in an organic compound. What is the nitrogen content of the organic compound?

a.) 5
b.) 30
c.) 50
d.) 80

Correct Answer. (c.) 50

Q2. Kjeldahl's method employs the following acid:

a.) conc. HNO_3
b.) conc. H_2SO_4
c.) dil.HNO_3
d.) dil. H_2SO_4

Correct Answer. (b.) conc. H_2SO_4
Explanation- Kjeldahl's method involves heating a nitrogen-containing compound with conc. H_2SO_4. The N_2 in the organic compound is converted to ammonium sulphate, which is then heated with NaOH, and the liberated ammonia is absorbed in excess of H_2SO_4.
Estimating the amount of sulphuric acid consumed in the reaction yields the amount of ammonia produced.

Q3. State True or False.
Kjeldahl's method for the estimation of nitrogen is applicable to all types of nitrogen-containing organic compounds.

Answer. False. Only nitrogen bound to organic components (proteins, amino acids, nucleic acids) and ammonium is measured in this method. This method is incompatible with compounds containing nitrogen in azo and nitro groups or rings (quinoline, pyridine, nitrate, nitrite, etc.).

Q4. Explain the distillation process in Kjeldahl's method.

Answer. Distillation is used to separate ammonia (nitrogen) from the digestion mixture. This is accomplished by-

- Sodium hydroxide is used to raise the pH of the mixture (45 % NaOH solution). This converts ammonium (NH_4^+) ions (which are dissolved in the liquid) to ammonia (NH_3), which is a gas.
- Removing nitrogen from the digestion mixture by distilling the ammonia (converting it to a volatile gas by raising the temperature to boiling point) and then trapping the distilled vapors in a special trapping solution of about 15 ml HCl (hydrochloric acid) in 70 ml of water.
- Removing the trapping flask and thoroughly rinsing the condenser with water to ensure that all ammonia has been dissolved

Q5. Explain the three-step procedure of Kjeldahl's method.

Answer. The Kjeldahl method consists of three steps that must be carefully followed in order:

- The sample is first digested in strong sulfuric acid with a catalyst to aid in the conversion of amine nitrogen to ammonium ions.
- Ammonium ions are then converted into ammonia gas, which is then heated and distilled. The ammonia gas is introduced into a trapping solution, where it dissolves and reverts to an ammonium ion.
- Finally, the amount of ammonia trapped is determined through titration with a standard solution and calculation.