A Steel Container Of Mass 140 G Contains 22.0 G Of Ammonia, NH3, Which Has A Molar Mass Of 17.0 G/mol.

A Steel Container Of Mass 140 G Contains 22.0 G Of Ammonia, NH3, Which Has A Molar Mass Of 17.0 G/mol.
This scenario provides a valuable opportunity to explore fundamental concepts in chemistry, including molar mass calculations, molar quantities, concentration analysis, and the properties of ammonia (NH_3). Understanding these principles is essential for students, professionals, and enthusiasts working in fields such as chemical engineering, laboratory sciences, and environmental studies. In this comprehensive guide, we will analyze the problem step by step, explain key concepts, and demonstrate how to perform relevant calculations, all structured to optimize understanding and SEO relevance.

Understanding the Basic Data and Concepts

Before delving into calculations, it’s vital to interpret the given data correctly:

- Mass of the steel container: 140 grams
- Mass of ammonia (NH_3): 22.0 grams
- Molar mass of ammonia (NH_3): 17.0 grams per mole

These data points serve as the foundation for further calculations, including the number of moles of ammonia present, the concentration within the container, and the implications for chemical reactions or storage.

Calculating the Number of Moles of Ammonia (NH_3)

The core step in understanding the chemical composition involves converting the mass of ammonia into moles. This process uses the molar mass:

Formula for Moles Calculation

\[
\text{Number of moles} = \frac{\text{Mass of substance}}{\text{Molar mass of substance}}

\]

Applying this to the ammonia:

\[
\text{Moles of NH}_3 = \frac{22.0\, \text{g}}{17.0\, \text{g/mol}} \approx 1.294\, \text{mol}
\]

Key Takeaway:
Approximately 1.294 moles of ammonia are contained within the steel container.

Determining the Mole Fraction and Concentration

Understanding the concentration of ammonia in the container involves considering the total volume or the partial pressure if the container's volume is known. While the problem doesn't specify the volume, we can discuss general principles:

1. Mole Fraction of Ammonia
The mole fraction indicates the proportion of ammonia relative to the total number of moles in the gas mixture (if applicable). To determine mole fraction, the total moles in the system are needed, which typically involves knowing the total volume and temperature.

2. Molar Concentration (if volume is known)
The molar concentration (mol/L) can be calculated as:

\[
\text{Concentration} = \frac{\text{Number of moles}}{\text{Volume in liters}}
\]

Without the volume, this remains theoretical, but understanding the relationship helps in various chemical calculations.

Mass and Density Considerations of the Steel Container

The total mass of the container (140 g) and the mass of ammonia (22 g) allow us to analyze the composition:

- Mass of steel container: 140 g
- Mass of ammonia inside: 22 g
- Remaining mass (possibly other contents or container mass):

$$
140\, \text{g} - 22\, \text{g} = 118\, \text{g}
$$

This residual mass could include the container's material and any residual gases or contents.

Key Points:

- The container's own mass is significant for assessing total system weight.
- Mass of ammonia indicates storage safety and capacity considerations.

Implications for Storage and Safety

Ammonia is widely used in various industrial processes, including refrigeration and fertilizer production. Proper storage is critical due to its toxicity and corrosive nature.

Safety Considerations:

- Container Material: Steel is chosen for its strength and resistance to corrosion, although ammonia can cause steel to corrode over time.
- Pressure and Temperature: Ammonia’s gaseous state depends on temperature and pressure; thus, knowing the amount helps in designing safe storage systems.

Storage Guidelines:

- Ensure the container is sealed properly to prevent leaks.
- Store in well-ventilated areas to mitigate toxicity risks.
- Regularly inspect for corrosion or damage.

Understanding Ammonia’s Chemical Properties

To contextualize the significance of the amount stored, it’s helpful to review ammonia’s key properties:

Property	Value or Description
Chemical formula	NH_3
Molar mass	17.0 g/mol
State at room temperature	Gas
Boiling point	-33.34°C
Density (liquid)	0.73 g/mL (at boiling point)

Toxicity	Highly toxic; exposure can cause severe health issues

Understanding these properties guides safe handling, storage, and usage.

Calculations for Reaction and Use Scenarios

Suppose the stored ammonia is intended for a chemical reaction or process. Calculations might include:

1. Moles of NH_3 Needed for a Reaction

For example, if a process requires 2 mol of NH_3:

$$
\text{Number of reactions} = \frac{\text{Available moles}}{\text{Moles per reaction}} = \frac{1.294\, \text{mol}}{2\, \text{mol/reaction}} \approx 0.647
$$

Indicating the amount of ammonia available is sufficient for approximately 0.647 reactions.

2. Volume of Ammonia Gas at Standard Conditions

Using the ideal gas law:

$$
PV = nRT
$$

Where:
- P = pressure (atm)
- V = volume (L)
- n = moles (1.294 mol)
- R = 0.0821 L·atm/(mol·K)
- T = temperature in Kelvin (assumed standard 273.15 K)

Assuming standard conditions (P=1 atm, T=273.15 K):

$$
V = \frac{nRT}{P} = \frac{1.294 \times 0.0821 \times 273.15}{1} \approx 29.1\, \text{L}
$$

Implication:
Approximately 29.1 liters of ammonia gas are present in the container at standard conditions.

Environmental and Industrial Significance

Ammonia's widespread industrial use makes understanding its storage and handling critical. Proper calculations ensure:

- Efficient storage: Maximizing capacity without risking over-pressurization.
- Environmental safety: Preventing leaks that could harm ecosystems.
- Operational safety: Ensuring personnel safety through accurate measurement and handling procedures.

Summary and Key Takeaways

- Converting mass to moles provides essential insights into the chemical composition of stored ammonia.
- The molar mass of NH_3 (17.0 g/mol) is crucial for these calculations.
- The amount of ammonia (22.0 g) equates to approximately 1.294 moles.
- The total volume of ammonia gas at standard conditions is roughly 29.1 liters.
- Storage considerations involve container material, safety protocols, and environmental factors.
- Knowledge of ammonia’s properties aids in safe handling, especially given its toxicity and corrosiveness.

Conclusion

Analyzing a steel container holding 22.0 grams of ammonia highlights essential chemical principles and practical considerations for storage and usage. Accurate calculations of molar quantities enable engineers and chemists to design safe storage systems, plan chemical processes, and ensure safety protocols are in place. This comprehensive understanding underscores the importance of fundamental chemistry concepts in real-world applications, from industrial manufacturing to environmental management.

Keywords: ammonia storage, molar mass, chemical calculations, chemical safety, ammonia properties, industrial storage, chemical engineering, molar quantity, gas law, environmental safety

Frequently Asked Questions

What is the molar mass of ammonia (NH_3)?

The molar mass of ammonia (NH_3) is 17.0 g/mol.

How many moles of ammonia are contained in the container?

There are approximately 1.29 moles of ammonia in the container, calculated by dividing 22.0 g by 17.0 g/mol.

What is the total mass of the steel container?

The total mass of the steel container is 140 g.

What is the mass of the steel container excluding ammonia?

The mass of the steel container alone is 118 g, obtained by subtracting 22.0 g of ammonia from the total mass.

How can the amount of ammonia in moles be calculated from its mass?

By dividing the mass of ammonia (22.0 g) by its molar mass (17.0 g/mol), we find approximately 1.29 moles of NH_3.

Why is it important to know the number of moles of ammonia in the container?

Knowing the number of moles helps in calculating chemical reactions, concentrations, and understanding the behavior of ammonia in various processes.

Additional Resources

A Steel Container Of Mass 140 G Contains 22.0 G Of Ammonia, NH_3, Which Has A Molar Mass Of 17.0 G/mol

---

Introduction

In the realm of chemical analysis and industrial chemistry, understanding the state, composition, and behavior of gases within sealed containers is paramount. The particular case of a steel container holding a known mass of ammonia (NH_3) presents an intriguing scenario for investigative analysis, combining aspects of physical chemistry, thermodynamics, and material science. This review delves into the fundamental principles underlying the given data: a steel container with a mass of 140 grams containing 22.0 grams of ammonia, which has a molar mass of 17.0 g/mol. Through methodical exploration, we aim to elucidate the implications of this setup, determine the amount of substance involved, and contextualize the findings within practical and theoretical frameworks.

Background and Context

Ammonia is a widely used industrial chemical, essential in fertilizer production, refrigeration, and chemical synthesis. Its physical properties, such as molar mass, vapor pressure, and thermodynamic behavior, are well-characterized, making it an ideal candidate for laboratory and industrial calculations.

The scenario involves a steel container—an inert, sturdy vessel capable of withstanding pressures associated with gaseous ammonia. The container's mass (140 g) includes both the steel and the ammonia inside. The mass of ammonia (22.0 g) is specified, enabling calculations of the number of moles and subsequent analyses.

This case raises several investigative questions:
- What is the amount of ammonia in mols?
- What is the molar ratio of ammonia to the container mass?
- What is the pressure of ammonia inside the container under standard or specified conditions?
- How does the container's material influence the stability or safety considerations?
- What are the thermodynamic implications of the given data?

Quantitative Analysis: Moles of Ammonia

The first step in the investigation involves quantifying the ammonia in mols, which is fundamental for understanding the chemical and physical behavior of the system.

Calculation of Moles of NH_3

Given:
- Mass of ammonia, $m_{NH_3} = 22.0\, \text{g}$
- Molar mass of ammonia, $M_{NH_3} = 17.0\, \text{g/mol}$

Number of moles, n_{NH_3}, is calculated via:

$$
n_{NH_3} = \frac{m_{NH_3}}{M_{NH_3}} = \frac{22.0\, \text{g}}{17.0\, \text{g/mol}} \approx 1.294\, \text{mol}
$$

This precise quantification frames subsequent calculations, including pressure and molar ratios.

Physical State and Conditions of Ammonia in the Container

The physical state of ammonia—gas, liquid, or equilibrium—depends on temperature and pressure conditions. Since the problem does not specify temperature or pressure, standard conditions (STP: 0°C and 1 atm) serve as a reference point, but real-world applications often involve elevated pressures or temperatures.

Assumption 1: Ammonia as a Gaseous Substance at STP

At STP, 1 mol of gas occupies approximately 22.4 liters. Using this, the volume of ammonia, if gaseous and at standard conditions:

$$
V_{NH_3} = n_{NH_3} \times 22.4\, \text{L} \approx 1.294\, \text{mol} \times 22.4\, \text{L/mol} \approx 29.0\, \text{L}
$$

This volume exceeds typical container sizes, indicating that the actual state depends on the temperature and pressure conditions inside the container. If the container is sealed and at room temperature, the ammonia might be compressed or liquefied.

Assumption 2: Ammonia as a Liquid or Under Pressure

Ammonia's boiling point at atmospheric pressure is approximately -33.3°C. Under higher pressures, it liquefies. The container's material and size influence whether ammonia remains gaseous or condenses.

Material Considerations: Steel Container Properties

The steel container's mass (140 g) provides context about its size and durability. Steel is known for its strength, corrosion resistance, and inertness, making it suitable for storing ammonia.

Calculating the Container's Volume

Assuming the container is made of typical carbon steel with a density of approximately 7.85 g/cm^3, the volume of the steel part is:

$$
V_{steel} = \frac{m_{steel}}{\rho_{steel}} = \frac{140\, \text{g}}{7.85\, \text{g/cm}^3} \approx 17.83\, \text{cm}^3
$$

If the total volume of the container is known or estimated, the remaining volume would be available for ammonia, influencing its state.

Thermodynamic Implications: Pressure and Safety Considerations

Given the amount of ammonia and the container's volume, estimating the internal pressure is feasible using the ideal gas law:

$$
PV = nRT
$$

Where:
- P = pressure inside the container
- V = volume of the container (minus the steel volume if considering internal space)
- n = moles of ammonia (~1.294 mol)
- R = universal gas constant (8.314 J/mol·K)
- T = temperature in Kelvin

Example Calculation at Room Temperature (25°C = 298 K)

Suppose the internal volume is approximately 100 cm^3 (a typical small container), then:

$$
V_{internal} = 100\, \text{cm}^3 = 1 \times 10^{-4}\, \text{m}^3
$$

Applying the ideal gas law:

$$
P = \frac{nRT}{V} = \frac{1.294\, \text{mol} \times 8.314\, \text{J/mol·K} \times 298\, \text{K}}{1 \times 10^{-4}\, \text{m}^3}
$$

$$
P \approx \frac{3,213}{1 \times 10^{-4}} = 32,130,000\, \text{Pa} \approx 321\, \text{atm}
$$

This extremely high pressure suggests that, under these assumptions, the ammonia would be liquefied or under significant compression, emphasizing the importance of understanding real conditions and safety protocols.

Safety and Industrial Relevance

Handling ammonia in sealed steel containers necessitates strict safety measures. Ammonia's toxicity, corrosiveness, and potential for high-pressure buildup pose risks. Industrial storage tanks are designed to withstand such pressures, often equipped with pressure relief valves.

Furthermore, the calculated pressure underscores the importance of precise control of temperature and volume, as ammonia's phase and pressure are highly sensitive to conditions.

Analytical and Practical Applications

Understanding the specifics of a container with known mass and contents enables:
- Accurate calculation of molar quantities for reaction stoichiometry
- Assessment of phase states under varying conditions
- Design of safe storage and transport systems
- Evaluation of material compatibility and corrosion risks
- Thermodynamic modeling of ammonia behavior in different environments

---

Additional Considerations and Limitations

- The assumption of ideal gas behavior simplifies calculations but may not be accurate at high pressures or low temperatures.
- Exact container volume, internal pressure, and temperature are critical for precise analysis.
- Real-world ammonia storage involves considerations of vapor pressure, liquefaction, and safety standards.

Conclusion

The investigation into a steel container weighing 140 grams and containing 22.0 grams of ammonia reveals significant insights into the chemical and physical behavior of ammonia in sealed environments. Quantifying the amount of substance (approximately 1.294 mol), understanding the potential pressures involved, and considering material properties are essential for ensuring safe handling and effective utilization.

This analysis underscores the importance of integrating chemical principles with engineering considerations in industrial and laboratory settings. Future studies could involve experimental measurements of pressure and temperature, as well as exploring the phase equilibria of ammonia under various conditions to optimize storage and application strategies.

References

- Atkins, P., & de Paula, J. (2010). Physical Chemistry. Oxford University Press.
- Lide, D. R. (Ed.). (2004). CRC Handbook of Chemistry and Physics. CRC Press.
- OSHA. (2023). Ammonia Safety and Health Guidelines. Occupational Safety and Health Administration.
- Perry, R. H., & Green, D. W. (2008). Perry’s Chemical Engineers’ Handbook. McGraw-Hill Education.

Note: This article is intended for educational and analytical purposes, providing a comprehensive overview of the principles involved in assessing the contents and conditions of a sealed ammonia container.

A Steel Container Of Mass 140 G Contains 22 0 G Of Ammonia Nh3 Which Has A Molar Mass Of 17 0 G Mol

A Steel Container Of Mass 140 G Contains 22 0 G Of Ammonia Nh3 Which Has A Molar Mass Of 17 0 G Mol

Related Articles

- 3. The Sports Club Plans To Pay No Dividends For 2 Years And Then In Year 3 To Pay A Dividend Of $1.20
- A Sperm May Need To Undergo Changes In Order To Become Compatible With The Egg. Which Of The Following
- A Physician Who Performs A Surgical Procedure On A Patient Without Obtaining The Patient's Consent May

Back to Home