

## Gravimetric Analysis Calculation Questions

Gravimetric Analysis Calculation Questions Gravimetric Analysis Calculation Questions A Comprehensive Guide Gravimetric analysis is a fundamental analytical technique used to determine the mass of a specific analyte in a sample. This method relies on the precise measurement of the mass of a precipitate formed through a chemical reaction between the analyte and a suitable reagent. The principle of gravimetric analysis is straightforward: the mass of the precipitate is directly proportional to the mass of the analyte in the original sample. This guide provides a comprehensive overview of gravimetric analysis calculation questions, covering various aspects of the technique and offering a step-by-step approach to solving problems.

**Key Concepts and Definitions**

**Analyte:** The specific component of interest in a sample that is being analyzed.

**Precipitate:** The solid compound formed during the chemical reaction between the analyte and the reagent.

**Precipitating Agent:** The reagent used to react with the analyte and form the precipitate.

**Gravimetric Factor:** The ratio of the molecular weight of the analyte to the molecular weight of the precipitate. This factor allows for the conversion of the mass of the precipitate to the mass of the analyte.

**Stoichiometry:** The study of the quantitative relationships between reactants and products in chemical reactions. It helps in understanding the mole ratios involved in the reaction.

**Types of Gravimetric Analysis**

Gravimetric analysis can be broadly classified into two main categories:

- 1. Precipitation Gravimetry:** This method involves the precipitation of the analyte as an insoluble compound by adding a suitable precipitating agent. The precipitate is then filtered, washed, dried, and weighed.
- 2. Volatilization Gravimetry:** In this method, the analyte is selectively volatilized from the sample by heat or chemical reaction. The volatile component is collected and measured, and the mass of the analyte is determined by difference.

**Common Calculation Questions**

Lets delve into some common calculation questions encountered in gravimetric analysis:

- 1. Determining the Mass of Analyte from the Mass of Precipitate**  
**Problem:** A sample of limestone ( $\text{CaCO}_3$ ) weighing 0.500 g was dissolved in acid, and the calcium ions were precipitated as calcium oxalate ( $\text{CaC}_2\text{O}_4$ ). The mass of the dried calcium oxalate precipitate was found to be 0.350 g. Calculate the percentage of calcium carbonate in the limestone sample.  
**Solution:**  
1. Write the balanced chemical equation for the reaction:  
$$\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2$$
  
2. Calculate the gravimetric factor:  
Gravimetric Factor =  $\frac{\text{Molecular Weight of CaCO}_3}{\text{Molecular Weight of CaC}_2\text{O}_4}$   
Gravimetric Factor =  $\frac{100.09 \text{ g/mol}}{128.10 \text{ g/mol}} = 0.782$   
3. Calculate the mass of

$\text{CaCO}_3$  in the precipitate Mass of  $\text{CaCO}_3$  Mass of  $\text{CaC}_2\text{O}_4 \times$  Gravimetric Factor Mass of  $\text{CaCO}_3$   $0.350 \text{ g} \times 0.782$   $0.274 \text{ g}$  4  
 Calculate the percentage of  $\text{CaCO}_3$  in the limestone sample  $\text{CaCO}_3$  Mass of  $\text{CaCO}_3$  Mass of Limestone Sample  $\times 100$   $\text{CaCO}_3$   
 $0.274 \text{ g} / 0.500 \text{ g} \times 100$   $54.8\%$  2 Calculating the Mass of Precipitate from the Mass of Analyte Problem A solution containing  $0.100 \text{ g}$  of  
 chloride ions  $\text{Cl}^-$  is treated with silver nitrate solution to precipitate silver chloride  $\text{AgCl}$  Calculate the theoretical yield of  $\text{AgCl}$   
 precipitate Solution 3 1 Write the balanced chemical equation for the reaction  $\text{AgNO}_3 \text{ (aq)} + \text{Cl}^- \text{ (aq)} \rightarrow \text{AgCl} \text{ (s)} + \text{NO}_3^- \text{ (aq)}$  2 Calculate the  
 moles of chloride ions Moles of  $\text{Cl}^-$  Mass of  $\text{Cl}^-$  Molecular Weight of  $\text{Cl}^-$  Moles of  $\text{Cl}^-$   $0.100 \text{ g} / 35.45 \text{ g/mol}$   $0.00282 \text{ mol}$  3 Use the  
 stoichiometric ratio from the balanced equation to determine the moles of  $\text{AgCl}$  Moles of  $\text{AgCl}$  Moles of  $\text{Cl}^-$  Moles of  $\text{AgCl}$   $0.00282$   
 $\text{mol}$  4 Calculate the mass of  $\text{AgCl}$  precipitate Mass of  $\text{AgCl}$  Moles of  $\text{AgCl} \times$  Molecular Weight of  $\text{AgCl}$  Mass of  $\text{AgCl}$   $0.00282 \text{ mol}$   
 $\times 143.32 \text{ g/mol}$   $0.404 \text{ g}$  3 Calculating the Concentration of Analyte Problem A  $1000 \text{ mL}$  sample of a solution containing an unknown  
 concentration of barium ions  $\text{Ba}^{2+}$  was treated with excess sodium sulfate  $\text{Na}_2\text{SO}_4$  to precipitate barium sulfate  $\text{BaSO}_4$  The  
 precipitate was filtered dried and weighed to be  $0.150 \text{ g}$  Calculate the concentration of barium ions in the original solution in  $\text{mg/L}$   
 Solution 1 Calculate the moles of  $\text{BaSO}_4$  Moles of  $\text{BaSO}_4$  Mass of  $\text{BaSO}_4$  Molecular Weight of  $\text{BaSO}_4$  Moles of  $\text{BaSO}_4$   $0.150 \text{ g}$   
 $233.39 \text{ g/mol}$   $0.000643 \text{ mol}$  2 Use the stoichiometric ratio from the balanced equation to determine the moles of  $\text{Ba}^{2+}$  Moles of  $\text{Ba}^{2+}$   
 Moles of  $\text{BaSO}_4$  Moles of  $\text{Ba}^{2+}$   $0.000643 \text{ mol}$  3 Calculate the concentration of  $\text{Ba}^{2+}$  in the original solution Concentration of  $\text{Ba}^{2+}$   
 Moles of  $\text{Ba}^{2+}$  Volume of Solution  $\times 1000 \text{ mg/g}$  Concentration of  $\text{Ba}^{2+}$   $0.000643 \text{ mol} / 0.100 \text{ L} \times 1000 \text{ mg/g}$   $6.43 \text{ mg/L}$  4 Practical  
 Applications of Gravimetric Analysis Gravimetric analysis finds wide applications in various fields including Environmental  
 Chemistry Determining the levels of heavy metals pollutants and other contaminants in water soil and air Food Chemistry  
 Analyzing the composition of food products such as the fat content in milk or the salt content in processed foods Pharmaceutical  
 Analysis Determining the purity and potency of drugs and pharmaceuticals Industrial Chemistry Monitoring and controlling the  
 quality of raw materials and finished products in various industries Forensic Science Analyzing evidence to identify substances  
 and trace elements Challenges and Limitations While gravimetric analysis is a powerful technique it also has its limitations  
 Timeconsuming The process can be timeconsuming due to the need for filtration washing drying and weighing steps Not suitable  
 for all analytes Some analytes may not form suitable precipitates or may be volatile at high temperatures Sensitivity The method  
 may not be sensitive enough to detect trace levels of analytes Interferences Other components in the sample may interfere with  
 the precipitation reaction leading to inaccurate results Conclusion Gravimetric analysis is a versatile analytical technique that  
 provides accurate and precise results when properly executed Understanding the key concepts mastering the calculation  
 procedures and recognizing potential challenges are crucial for successful application of this method By carefully selecting the  
 appropriate precipitation reaction and controlling the experimental conditions gravimetric analysis remains a valuable tool for

determining the mass of analytes in various samples across diverse fields

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