

Perform The Following Operations Expressing The Answer With The Correct Number Of Significant Figures.

Perform The Following Operations Expressing The Answer With The Correct Number Of Significant Figures.

Introduction

In scientific and mathematical calculations, precision and accuracy are paramount. When performing arithmetic operations such as addition, subtraction, multiplication, or division, it is essential to express the final answer with the correct number of significant figures. Significant figures (also known as significant digits) indicate the precision of a measured or calculated value. Properly applying significant figures ensures that results neither overstate nor understate the certainty of the data, maintaining integrity in scientific communication.

This article provides a comprehensive guide on how to perform various mathematical operations while correctly expressing answers with the appropriate number of significant figures. Whether you're a student tackling chemistry problems, a researcher analyzing experimental data, or a professional ensuring precision in calculations, understanding these principles is crucial for accurate reporting and interpretation of results.

What Are Significant Figures?

Definition

Significant figures are the digits in a number that carry meaningful contributions to its precision. They include all non-zero digits, zeros between significant digits, and certain trailing zeros depending on context.

Rules for Identifying Significant Figures

- Non-zero digits are always significant.

Example: 123.45 has 5 significant figures.

- Leading zeros are not significant; they merely indicate the position of the decimal point.

Example: 0.00456 has 3 significant figures.

- Captive zeros (zeros between non-zero digits) are significant.

Example: 1002 has 4 significant figures.

- Trailing zeros are significant if they follow a decimal point.

Example: 2.300 has 4 significant figures.

- Trailing zeros in a whole number with no decimal point are ambiguous and often not considered significant unless specified.

Example: 1500 may have 2, 3, or 4 significant figures, depending on context or notation (e.g., 1500., 1.500×10^3).

Importance of Significant Figures

Using the correct number of significant figures:

- Reflects the precision of the measurement tools used.
- Prevents over-interpretation of data.
- Ensures consistency and accuracy in scientific reporting.

Basic Arithmetic Operations and Significant Figures

Addition and Subtraction

When adding or subtracting, the number of decimal places in the result should match the measurement with the least decimal places.

Rules

- Identify the number with the fewest decimal places.
- Round the final answer to that same number of decimal places.

Example

Calculate: $12.11 + 0.023 + 1.1$

- 12.11 has 2 decimal places.
- 0.023 has 3 decimal places.
- 1.1 has 1 decimal place.

The limiting factor is 1.1 with 1 decimal place.

Solution:

Sum: $12.11 + 0.023 + 1.1 = 13.253$

Round to 1 decimal place: 13.3

Multiplication and Division

When multiplying or dividing, the number of significant figures in the result should match that of the measurement with the fewest significant figures.

Rules

- Identify the number with the fewest significant figures.

- Round the final answer to that same number of significant figures.

Example

Calculate: 4.56×1.4

- 4.56 has 3 significant figures.
- 1.4 has 2 significant figures.

The limiting factor is 1.4 with 2 significant figures.

Solution:

Product: $4.56 \times 1.4 = 6.384$

Round to 2 significant figures: 6.4

Performing Complex Operations with Multiple Steps

When calculations involve multiple steps, it is best practice to retain the full precision during intermediate steps and apply significant figure rules only to the final result. This approach minimizes rounding errors.

Step-by-step Approach

1. Perform all calculations without rounding until the final step.
2. Apply the appropriate significant figure rule to the final answer.
3. Always double-check the number of significant figures in the original data.

Scientific Notation and Significant Figures

Scientific notation simplifies working with very large or small numbers and clearly indicates significant figures.

Rules in Scientific Notation

- The digits in the coefficient are significant.
- The exponent does not affect the number of significant figures.

Example

- 3.00×10^4 has 3 significant figures.
- 4.56×10^{-3} has 3 significant figures.

When performing operations:

- Convert numbers to scientific notation if it clarifies significant figures.

- Follow the same rules for multiplication/division and addition/subtraction.

Common Scenarios and Practice Problems

Scenario 1: Addition with different decimal places

Calculate: $0.0567 + 0.0034 + 1.2$

- 0.0567 (4 decimal places)
- 0.0034 (4 decimal places)
- 1.2 (1 decimal place)

Limiting decimal places: 1 decimal place (from 1.2)

Answer:

Sum: $0.0567 + 0.0034 + 1.2 = 1.2601$

Rounded to 1 decimal place: 1.3

Scenario 2: Multiplication involving significant figures

Calculate: 0.00456×123.45

- 0.00456 has 3 significant figures.
- 123.45 has 5 significant figures.

Limiting significant figures: 3

Answer:

Product: $0.00456 \times 123.45 \approx 0.563172$

Rounded to 3 significant figures: 0.563

Scenario 3: Division with zeros and significant figures

Calculate: $7.890 \div 0.1234$

- 7.890 has 4 significant figures.
- 0.1234 has 4 significant figures.

Result: $7.890 \div 0.1234 \approx 63.974$

Rounded to 4 significant figures: 63.97

Applying Significant Figures in Real-World Contexts

Scientific Research

In laboratories, measurements are often limited by instrument precision. Properly reporting results with correct significant figures communicates the reliability of data.

Engineering Calculations

Design specifications must reflect tolerances, which are often expressed with a certain number of significant figures to ensure safety and functionality.

Educational Settings

Students learning physics or chemistry are taught to recognize significant figures to develop accurate problem-solving skills and scientific literacy.

Summary of Key Principles

- Addition/Subtraction: Round to the fewest decimal places.
- Multiplication/Division: Round to the fewest significant figures.
- Intermediate steps: Keep full precision until the final answer.
- Scientific notation: Use significant figures in the coefficient; the exponent is not counted.
- Zeros: Understand their significance based on position and notation.

Final Tips for Accurate Calculations

- Always identify the number of significant figures in your data before performing operations.
- Use scientific notation for very large or small numbers to clearly indicate significant figures.
- Be cautious with trailing zeros; their significance depends on decimal placement.
- Avoid unnecessary rounding during intermediate steps.
- Review your final answer to ensure it correctly reflects the precision of your data.

Conclusion

Performing mathematical operations with attention to significant figures is a fundamental skill in science, engineering, and mathematics. By understanding the rules for addition, subtraction, multiplication, and division, and applying them consistently, you ensure that your results accurately represent the precision of your measurements and calculations. Properly expressing answers with the correct number of significant figures not only enhances the credibility of your work but also aligns with scientific standards for data reporting.

Mastering these principles will improve your problem-solving accuracy and help you communicate findings effectively, whether in academic, professional, or everyday contexts. Remember: precision matters, and significant figures are the key to expressing it correctly.

Frequently Asked Questions

How do you determine the correct number of significant figures when adding or subtracting measurements?

When adding or subtracting, the result should be reported with the same number of decimal places as the measurement with the fewest decimal places.

What is the rule for expressing the answer with the correct significant figures during multiplication or division?

In multiplication or division, the answer should be rounded to the same number of significant figures as the measurement with the fewest significant figures.

If you multiply 3.456 (4 significant figures) by 0.078 (2 significant figures), what should be the correct answer's significant figures?

The answer should be reported with 2 significant figures, matching the measurement with the fewest significant figures, so the result is rounded accordingly.

When adding 12.345 (5 significant figures) and 0.0067 (2 significant figures), what is the correct way to express the answer?

The sum should be rounded to 2 decimal places, matching the measurement with the fewest decimal places, resulting in 12.3517 rounded to 12.35.

Why is it important to correctly express answers with the right number of significant figures?

Because it accurately reflects the precision of the measurements and prevents overestimating the certainty of the result.

How should you handle significant figures in mixed operations involving both addition/subtraction and multiplication/division?

Perform each operation step-by-step, applying the relevant rules for significant figures at each stage to ensure the final answer has the correct precision.

What is the correct way to round 0.004567 to 3 significant

figures?

The number should be rounded to 0.00457, maintaining three significant figures.

Given 123.45 and 0.0067, how do you perform addition and express the answer with correct significant figures?

Add the numbers to get 123.4567, then round to the least precise decimal place (the hundredths place), resulting in 123.46.

What is the main purpose of expressing answers with the correct number of significant figures in scientific calculations?

To accurately communicate the precision of measurements and ensure consistency and reliability in scientific data reporting.

Additional Resources

Perform The Following Operations Expressing The Answer With The Correct Number Of Significant Figures

Introduction

In the realm of scientific computation and quantitative analysis, the importance of significant figures cannot be overstated. They serve as a measure of precision, reflecting the certainty of measurements and calculations. The directive "Perform The Following Operations Expressing The Answer With The Correct Number Of Significant Figures" encapsulates a fundamental principle in scientific reporting: the result must accurately reflect the precision of the data used.

This comprehensive review aims to explore the principles, methodologies, and best practices involved in performing mathematical operations—addition, subtraction, multiplication, division, and more complex functions—while maintaining correct significant figures. We will delve into the theoretical background, practical examples, common pitfalls, and guidelines that ensure integrity and clarity in scientific communication.

The Significance of Significant Figures in Scientific Calculations

Definition and Concept

Significant figures (often abbreviated as sig figs) are the digits in a number that carry meaningful contributions to its precision. This includes all non-zero digits, zeros between significant digits, and zeros that follow significant digits in certain contexts.

For example:

- 123.45 has five significant figures.
- 0.00456 has three significant figures.
- 7.8900 has five significant figures (the trailing zeros are significant because they indicate precision).

Why Are Significant Figures Important?

- Accuracy Representation: They convey the reliability of measurements and calculations.
- Consistency: Ensuring calculations do not imply unwarranted precision.
- Communication Clarity: Facilitating proper interpretation of data by scientists, engineers, and analysts.

Fundamental Rules for Significant Figures in Operations

Understanding how to correctly round and report results depends on the type of operation performed. Each operation has its own set of rules for determining the number of significant figures in the answer.

Addition and Subtraction

Rule:

The result should be rounded to the same decimal place as the measurement with the least decimal places.

Explanation:

When adding or subtracting, the precision is limited by the measurement with the fewest decimal places. The number of significant figures is less relevant here; the focus is on decimal places.

Example:

Calculate $12.11 + 0.023 + 1.1$

- 12.11 (two decimal places)
- 0.023 (three decimal places)
- 1.1 (one decimal place)

The least precise measurement is 1.1, with one decimal place.

Result:

$$12.11 + 0.023 + 1.1 = 13.253$$

Rounded to one decimal place:

Answer: 13.3

Multiplication and Division

Rule:

The result should be rounded to the same number of significant figures as the measurement with the fewest significant figures.

Explanation:

Here, the focus is on the total number of significant figures, not decimal places.

Example:

Calculate 4.56×1.4

- 4.56 (three significant figures)

- 1.4 (two significant figures)

The limiting measurement is 1.4 with two significant figures.

Result:

$$4.56 \times 1.4 = 6.384$$

Rounded to two significant figures:

Answer: 6.4

Combining Operations

When multiple operations are involved, follow the order of operations and apply significant figure rules at each step, or perform calculations exactly and then round at the end.

Practical Application and Step-by-Step Methodology

Step 1: Identify the significant figures in each measurement or number.

Step 2: Determine the type of operation(s) involved.

Step 3: Perform the calculation carefully, keeping track of intermediate significant figures.

Step 4: Round the final answer according to the relevant rules for the operation.

Step 5: Report the answer with the correct number of significant figures.

Common Pitfalls and How to Avoid Them

1. Rounding too early

Rounding intermediate results too early can lead to inaccuracies. It's best to carry extra digits through calculations and round only at the end.

2. Misapplying rules for addition/subtraction vs multiplication/division

Remember that addition/subtraction depends on decimal places, while multiplication/division depends on significant figures.

3. Ignoring zeros

Zeros can be tricky—know when zeros are significant (e.g., trailing zeros in a decimal number) and when they are not.

4. Overestimating precision

Avoid reporting more significant figures than justified by the data.

Advanced Topics

Significant Figures in Scientific Notation

Using scientific notation simplifies the handling of significant figures, especially with very large or small numbers.

Example:

- 3.00×10^4 has three significant figures.
- 4.560×10^{-3} has four significant figures.

Operations should be performed on the coefficient, and the final answer should maintain the proper number of significant figures.

Significant Figures in Complex Calculations

For complex calculations involving multiple steps:

- Carry extra digits during interim steps.
- Apply rounding only after completing the entire calculation.

Case Studies and Examples

Example 1: Addition and Multiplication

Calculate $(5.23 + 0.0075) \times 3.2$

Step 1: Add:

$$5.23 + 0.0075 = 5.2375$$

Since 5.23 has two decimal places and 0.0075 has four decimal places, the result should be rounded to two decimal places:

Intermediate sum: 5.24

Step 2: Multiply:

$$5.24 \times 3.2 = 16.768$$

The limiting factor is 3.2 with two significant figures.

Final answer:

16.768 rounded to two significant figures:

Answer: 17

Example 2: Multiple Operations with Different Significant Figures

Calculate: $(2.345 \times 10^3) \div (4.56 \times 10^{-2})$

Step 1: Write numbers:

- 2.345×10^3 (four significant figures)
- 4.56×10^{-2} (three significant figures)

Step 2: Divide:

$$(2.345 / 4.56) \approx 0.5146$$

The limiting significant figures are three (from 4.56).

Step 3: Adjust the power of ten:

$$(10^3) / (10^{-2}) = 10^{(3 - (-2))} = 10^5$$

Final result:

$$0.5146 \times 10^5 = 5.146 \times 10^4$$

Rounded to three significant figures:

$$\text{Answer: } 5.15 \times 10^4$$

Conclusion

Performing operations while expressing answers with the correct number of significant figures is a critical skill in scientific and technical disciplines. It ensures that reported data accurately reflects the precision of measurements and prevents the overstatement of certainty. Adhering to the fundamental rules—addition/subtraction based on decimal places, multiplication/division based on significant figures—is essential for maintaining integrity in calculations.

By understanding these principles, practicing with varied examples, and being mindful of common pitfalls, scientists and students alike can enhance the clarity and reliability of their quantitative analyses. Properly managing significant figures is not merely a procedural step but a cornerstone of scientific rigor and effective communication.

References

- Tro, N. J. (2017). Chemistry: A Molecular Approach. Pearson Education.
- Brown, T. L., LeMay, H. E., Bursten, B. E., Murphy, C., & Woodward, C. (2014). Chemistry: The Central Science. Pearson Education.
- Lide, D. R. (Ed.). (2004). CRC Handbook of Chemistry and Physics. CRC Press.

About the Author

This article was crafted by a scientific analyst with extensive experience in chemical and physical sciences, committed to promoting best practices in scientific computation and data reporting.

Perform The Following Operations Expressing The Answer With The Correct Number Of Significant Figures

Perform The Following Operations Expressing The Answer With The Correct Number Of Significant Figures

Related Articles

- [S. Pagan And T. Tabor Share Income On A 7:3 Basis. They Have Capital Balances Of \\$106,000 And \\$70,000.](#)
- [Let \$F\(t\)\$ Be A Function On \$\[0, \[\infty\)\)\$. The Laplace Transform Of \$F\$ Is The Function \$F\$ Defined By The](#)
- [Los Jugadores\(players\) No _____ Jugar. \(Fill In With The Correct CONJUGATION Of Saber Or Conocer](#)

[Back to Home](#)