Perform The Following Mathematical Operation, And Report The Answer To The Appropriate Number Of Significant

Perform The Following Mathematical Operation, And Report The Answer To The Appropriate Number Of Significant is a common instruction in mathematics, science, engineering, and various technical disciplines. This directive emphasizes the importance of not only solving a given problem but also presenting the final answer with the correct precision. Properly reporting significant figures ensures clarity, accuracy, and consistency in communication, especially when dealing with measurements and calculated results. In this article, we explore the principles behind performing mathematical operations with significant figures, how to determine the correct number of significant figures in your answer, and practical examples to strengthen your understanding.

Understanding Significant Figures

What Are Significant Figures?

Significant figures (often abbreviated as sig figs) are the digits in a number that carry meaningful contributions to its precision. They include all non-zero digits, zeros between significant digits, and trailing zeros in decimal numbers. The primary purpose of significant figures is to convey the level of certainty or accuracy in a measurement or calculation.

- Non-zero digits are always significant (e.g., 123.45 has five significant figures).
- Zeros between non-zero digits are significant (e.g., 1002 has four significant figures).
- Leading zeros are not significant (e.g., 0.0056 has two significant figures).
- Trailing zeros in a number with a decimal point are significant (e.g., 12.300 has five significant figures).
- Trailing zeros in a whole number without a decimal point may not be significant unless specified (e.g., 1500 may have two, three, or four significant figures depending on context).

Why Are Significant Figures Important?

Significant figures communicate the precision of a measurement or calculation. When performing mathematical operations, maintaining the correct number of significant

figures in the result prevents overstatement of precision and ensures scientific integrity.

Performing Mathematical Operations with Significant Figures

Addition and Subtraction

When adding or subtracting numbers, the result should be rounded to the least precise decimal place among the operands.

- **Example:** 12.11 + 0.0234 + 1.1
- Step 1: Identify decimal places:
    - 12.11 (two decimal places)
    - 0.0234 (four decimal places)
    - 1.1 (one decimal place)
- Step 2: Sum the numbers:
    - 12.11 + 0.0234 + 1.1 = 13.2334
- Step 3: Round to the least precise decimal place (one decimal place):
    - Result: 13.2

Key Point: The final answer has one decimal place because that was the least precise measurement.

Multiplication and Division

When multiplying or dividing, the result should be rounded to the number of significant figures in the operand with the fewest sig figs.

- **Example:** 4.56 × 1.4

- Step 1: Count significant figures:
    - 4.56 has three significant figures
    - 1.4 has two significant figures
- Step 2: Multiply:
    - $4.56 \times 1.4 = 6.384$
- Step 3: Round to two significant figures (the fewer in the operands):
    - Result: 6.4

Key Point: The answer maintains only as many significant figures as the least precise input.

Combining Operations and Significant Figures

When solving complex expressions involving multiple operations, follow the order of operations (PEMDAS/BODMAS) and apply the rules for significant figures at each step.

Step-by-Step Approach

1. Perform calculations inside parentheses first.
2. Handle exponentiation and roots next.
3. Carry out multiplication and division, applying the sig fig rules.
4. Finally, perform addition and subtraction, rounding appropriately.

This systematic approach ensures your final answer reflects the cumulative precision of all calculations.

Examples Demonstrating Proper Reporting of Significant Figures

Example 1: Complex Calculation

Calculate: (3.4567 × 2.1) + (0.0456 ÷ 3)

Step 1: Multiply 3.4567 (five sig figs) by 2.1 (two sig figs):
- Result: 3.4567 × 2.1 = 7.25807
- Round to two significant figures (least in operands): 7.3

Step 2: Divide 0.0456 (three sig figs) by 3 (one sig fig):
- Result: 0.0456 ÷ 3 = 0.0152
- Since 3 has one sig fig, round to one significant figure: 0.02

Step 3: Add the two results:
- 7.3 + 0.02 = 7.32

Step 4: Final answer should be reported with the appropriate significant figures based on the operation:
- Addition and subtraction are based on decimal places. The first number (7.3) has one decimal place; the second (0.02) has two decimal places.
- The sum, 7.32, is precise to two decimal places, but since our first number is only precise to one decimal place, we round to one decimal place: 7.3

Final Answer: 7.3

Example 2: Measurement and Calculation

Suppose you measure the length of an object as 12.3 cm and the width as 4.56 cm. Find its area, then report it with the correct significant figures.

Step 1: Multiply length and width:
- 12.3 × 4.56 = 56.088

Step 2: Determine the significant figures:
- 12.3 has three sig figs.
- 4.56 has three sig figs.
- The product should have three sig figs: 56.088 rounded to three sig figs is 56.1

Final Result: Area = 56.1 cm^2

Practical Tips for Accurate Reporting

- Always identify the significant figures in your initial measurements.
- Follow the specific rules for each operation.
- Use rounding carefully to avoid overestimating precision.
- When in doubt, keep extra digits during intermediate calculations and round only at the final step.
- Use scientific notation to clearly specify significant figures, especially for very large or very small numbers.

Conclusion

Performing mathematical operations and reporting the answer with the correct number of significant figures is vital for scientific accuracy and effective communication. Whether adding, subtracting, multiplying, or dividing, understanding and applying the rules for significant figures ensures your results are both precise and reliable. Remember that the key is always to match the precision of your final answer to the least precise measurement or calculation involved. Mastering these principles will improve your data analysis, enhance the credibility of your work, and foster a clearer understanding of numerical results in any scientific or technical context.

Frequently Asked Questions

How do I determine the number of significant figures in a result after performing a mathematical operation?

Identify the number of significant figures in each original measurement and then follow the rules for the operation (e.g., for multiplication/division, the result should have the same number of significant figures as the measurement with the fewest significant figures).

What is the correct way to report the answer to a calculation with significant figures?

Round your final answer to match the number of significant figures dictated by the least precise measurement involved in the calculation, ensuring accuracy and consistency.

When adding or subtracting measurements, how do I decide the number of significant figures in the result?

For addition or subtraction, report the result with the same number of decimal places as the measurement with the fewest decimal places among the original values.

Can you give an example of performing a mathematical operation and reporting the answer with the correct significant figures?

Sure! For example, multiplying 3.456 (4 sig figs) by 2.1 (2 sig figs) gives 7.2672. Reported with 2 sig figs, the answer is 7.3.

Why is it important to report answers with the correct number of significant figures?

Reporting with the correct significant figures reflects the precision of the original data and maintains the integrity of the measurement's accuracy.

Are there any special rules for reporting answers involving division and multiplication with significant figures?

Yes, for division and multiplication, the final answer should be rounded to the same number of significant figures as the measurement with the fewest significant figures in the calculation.

Additional Resources

Perform The Following Mathematical Operation, And Report The Answer To The Appropriate Number Of Significant Figures is a fundamental task in scientific, engineering, and mathematical contexts. Accurate reporting of results with the correct number of significant figures ensures precision, maintains consistency, and adheres to established standards of measurement. Whether you're solving complex equations or performing routine calculations, understanding how to perform operations and report the answer properly is crucial for clarity and professional integrity.

In this guide, we'll explore the principles behind performing various mathematical operations—addition, subtraction, multiplication, division, and more complex functions—and how to determine the appropriate number of significant figures for your final answer. We'll also provide practical tips, examples, and best practices to help you master this essential skill.

Understanding Significant Figures

Before diving into the operations themselves, it's important to understand what significant figures are and why they matter.

What Are Significant Figures?

Significant figures (or sig figs) are the digits in a number that carry meaningful contributions to its precision. They include all non-zero digits, zeros between non-zero digits, and trailing zeros in a decimal number.

Examples:

- 123.45 has 5 significant figures.
- 0.00456 has 3 significant figures.
- 1000 has 1 significant figure (unless specified otherwise).
- 1000.00 has 6 significant figures.

Why Are Significant Figures Important?

Reporting results with appropriate significant figures:

- Reflects the precision of the measurement or calculation.

- Prevents overstatement of the accuracy.
- Ensures consistency across scientific and engineering communications.

Performing Mathematical Operations with Significant Figures

Different operations have different rules for how many significant figures the final answer should contain. Understanding these rules is essential for accurate reporting.

1. Addition and Subtraction

Rule: The result should be rounded to the least precise decimal place among the numbers involved.

Explanation: When adding or subtracting, the precision of the answer is limited by the number with the fewest 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.

Step-by-step:

- Sum: 12.11 + 0.023 + 1.1 = 13.233

- The least precise measurement is with 1 decimal place (1.1).

- Round the sum to 1 decimal place: 13.2

Final answer: 13.2 (reported with 3 significant figures)

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2. Multiplication and Division

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

Example:

Calculate 4.56 × 1.4

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

Step-by-step:

- Multiply: 4.56 × 1.4 = 6.384

- Round to 2 significant figures: 6.4

Final answer: 6.4 (reported with 2 significant figures)

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3. Combining Operations

When calculations involve multiple steps with different operations, apply the rules step-by-step, and keep track of significant figures at each stage to ensure proper rounding at the end.

Advanced Considerations

Beyond basic operations, more complex calculations like powers, roots, logarithms, and exponential functions have their own rules for significant figures.

1. Powers and Roots

- For a quantity raised to a power, the number of significant figures remains the same as the original.
- When taking roots, the final result should be rounded to the same number of significant figures as the original number.

Example:

Calculate √(5.76)

- 5.76 has 3 significant figures.
- The square root should be reported with 3 significant figures.

√(5.76) ≈ 2.4 (since 2.4 has 2 significant figures, but because the original number has 3, round to 2.4 with 2 significant figures: 2.4.)

2. Logarithms and Exponentials

- When taking the logarithm, the number of decimal places in the result corresponds to the number of significant figures in the original number.
- When calculating antilogarithms, report the result with the same number of significant figures as the logarithm.

Practical Examples and Step-by-Step Guides

Let's examine some real-world scenarios to solidify these concepts.

Example 1: Scientific Measurement Calculation

Suppose you measure:

- Length of a wire: 12.34 cm
- Width of a wire: 0.00345 m
- Thickness: 1.2 mm

Question: Calculate the volume of the wire in cubic centimeters and report the answer with the appropriate significant figures.

Step 1: Convert all measurements to the same units (cm).

- Length: 12.34 cm (already in cm)
- Width: 0.00345 m = 0.345 cm
- Thickness: 1.2 mm = 0.12 cm

Step 2: Calculate the volume (assuming a rectangular cross-section):

$$ V = \text{length} \times \text{width} \times \text{thickness} $$

$$ V = 12.34\, \text{cm} \times 0.345\, \text{cm} \times 0.12\, \text{cm} $$

Step 3: Perform the multiplication:

- 12.34 × 0.345 = 4.255

- 4.255 × 0.12 = 0.5106

Step 4: Determine the number of significant figures:

- 12.34 has 4 sig figs.
- 0.345 has 3 sig figs.
- 0.12 has 2 sig figs.

The limiting factor is 0.12 (2 sig figs).

Step 5: Round the final answer to 2 significant figures:

0.5106 rounded to 2 sig figs is 0.51

Final answer: The volume of the wire is approximately 0.51 cubic centimeters.

Example 2: Combining Multiple Operations

Calculate the following:

$$ \frac{(8.23 \times 2.1) + 3.456}{4.56} $$

Step 1: Perform multiplication:

- 8.23 × 2.1

- 8.23 has 4 sig figs.

- 2.1 has 2 sig figs.

- Product: 8.23 × 2.1 = 17.283

- Round to 2 sig figs (least among the factors): 17

Step 2: Add 3.456:

- 17 + 3.456 = 20.456

- Addition rules: round to the least decimal precision.

- 17 has no decimal places, 3.456 has 3 decimal places.

- So, round to 0 decimal places: 20

Step 3: Divide by 4.56:

- 20 ÷ 4.56 ≈ 4.3859649

- 4.56 has 3 sig figs.

- Final answer should have 3 sig figs: 4.39

Final result: approximately 4.39

Best Practices for Accurate Reporting

- Always identify the number of significant figures in your original data before performing calculations.
- Follow the specific rules for each operation to determine how many significant figures your final answer should have.
- When in doubt, perform calculations with more digits internally, then round appropriately at the end.
- Be cautious with zeros: leading zeros are never significant; trailing zeros in a decimal are significant.
- Use scientific notation to clearly indicate significant digits and avoid ambiguity.

Common Pitfalls and How to Avoid Them

- Overrounding during intermediate steps: Keep extra digits until the final step to prevent

rounding errors.
- Ignoring zeros: Remember that zeros between non-zero digits are significant; trailing zeros in a decimal are significant.
- Misapplying rules: Always use the specific rule appropriate for the operation (addition/subtraction vs multiplication/division).

Conclusion

Perform The Following Mathematical Operation, And Report The Answer To The Appropriate Number Of Significant Figures is not just a procedural task but a vital aspect of scientific rigor. By understanding the rules governing significant figures and applying them consistently, you ensure your results are both accurate and meaningful. Whether handling simple calculations or complex equations, these principles help maintain clarity, precision, and professionalism in your work.

Mastery of significant figures enhances the quality of your data analysis, supports effective communication, and upholds the standards of scientific inquiry. Practice regularly with diverse examples, and you'll develop a keen intuition for when and how to adjust your answers to reflect true measurement precision.

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