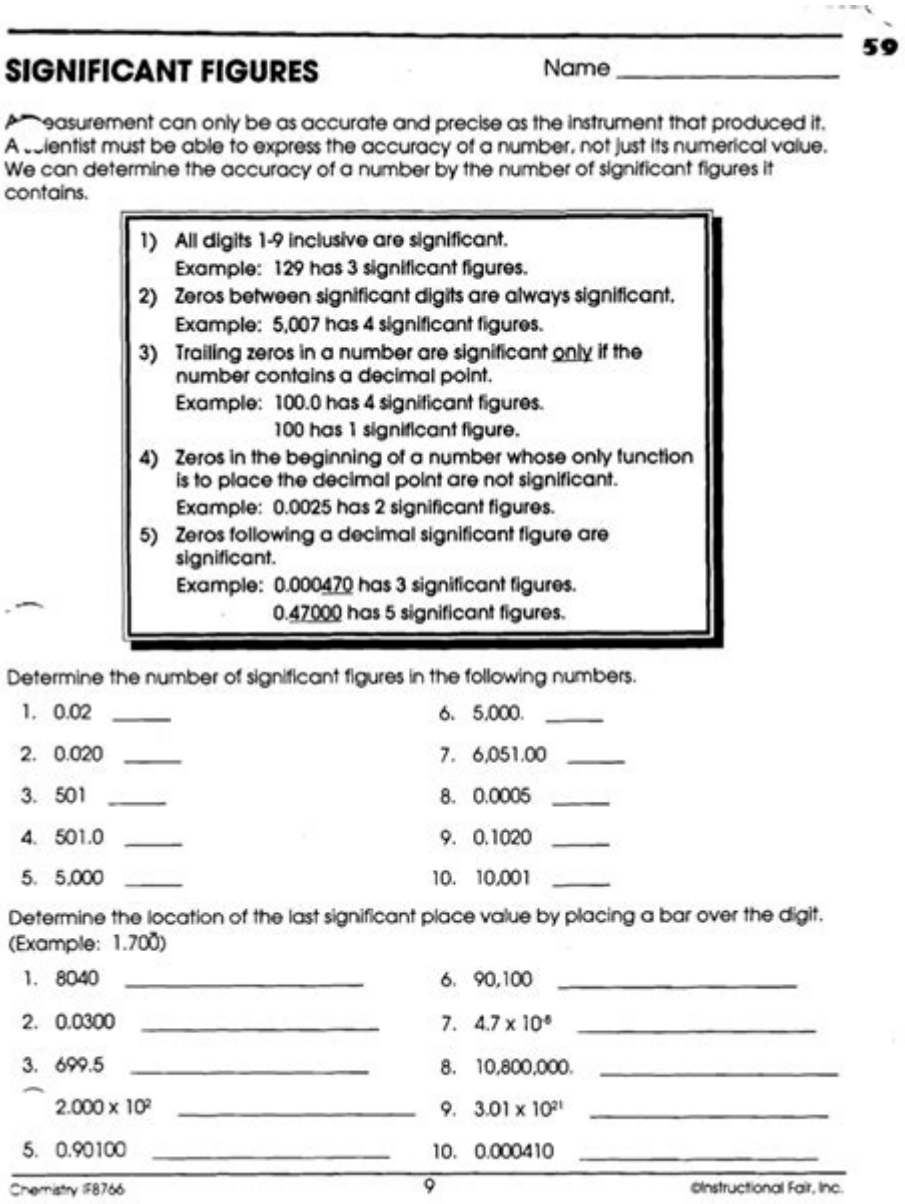
Calculations Using Significant Figures Answer Key



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SIGNIFICANT FIGURES Name _____

A measurement can only be as accurate and precise as the instrument that produced it. A scientist must be able to express the accuracy of a number, not just its numerical value. We can determine the accuracy of a number by the number of significant figures it contains.

1) All digits 1-9 inclusive are significant.
   Example: 129 has 3 significant figures.
2) Zeros between significant digits are always significant.
   Example: 5,007 has 4 significant figures.
3) Trailing zeros in a number are significant only if the number contains a decimal point.
   Example: 100.0 has 4 significant figures.
   100 has 1 significant figure.
4) Zeros in the beginning of a number whose only function is to place the decimal point are not significant.
   Example: 0.0025 has 2 significant figures.
5) Zeros following a decimal significant figure are significant.
   Example: 0.000470 has 3 significant figures.
   0.47000 has 5 significant figures.

Determine the number of significant figures in the following numbers.

1. 0.02 _____
2. 0.020 _____
3. 501 _____
4. 501.0 _____
5. 5,000 _____
6. 5,000. _____
7. 6,051.00 _____
8. 0.0005 _____
9. 0.1020 _____
10. 10,001 _____

Determine the location of the last significant place value by placing a bar over the digit. (Example: 1.700)

1. 8040 _____
2. 0.0300 _____
3. 699.5 _____
4. 2.000×10^2 _____
5. 0.90100 _____
6. 90,100 _____
7. 4.7×10^{-8} _____
8. 10,800,000. _____
9. 3.01×10^{21} _____
10. 0.000410 _____

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Calculations using significant figures answer key is a crucial topic in scientific disciplines, particularly in fields such as chemistry, physics, and engineering. Significant figures are the digits in a number that contribute to its precision. This concept is essential for ensuring that calculated results reflect the precision of the measurements used in calculations. In this article, we will explore the rules of significant figures, how to apply them in calculations, and provide examples with an answer key to solidify understanding.

Understanding Significant Figures

Significant figures can be defined as follows:

1. All non-zero digits are significant.
2. Any zeros between significant digits are also significant.
3. Leading zeros (zeros before the first non-zero digit) are not significant.
4. Trailing zeros in a number with a decimal point are significant.
5. Trailing zeros in a whole number without a decimal point are not significant.

Examples of Significant Figures

To illustrate these rules, consider the following examples:

- 123.45 has five significant figures.
- 0.00456 has three significant figures (the leading zeros are not counted).
- 1001 has four significant figures.
- 0.002500 has four significant figures (the trailing zeros after the decimal are significant).
- 100 has one significant figure unless specified otherwise, like in 100. (which has three significant figures).

Performing Calculations with Significant Figures

When performing calculations, it’s essential to maintain the correct number of significant figures in the final result. The rules for calculations using significant figures differ for addition/subtraction and multiplication/division.

Addition and Subtraction

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

Rule: The result should be rounded to the least number of decimal places in the numbers being added or subtracted.

Example:

Calculate $12.11 + 0.3 + 1.234$.

- Step 1: Identify decimal places:
- 12.11 has two decimal places.
- 0.3 has one decimal place.
- 1.234 has three decimal places.

- Step 2: The least number of decimal places is one (from 0.3).

- Step 3: Perform the calculation:
$$
12.11 + 0.3 + 1.234 = 13.644
$$

- Step 4: Round to one decimal place:
$$
\text{Final result} = 13.6
$$

Multiplication and Division

For multiplication and division, the result should have the same number of significant figures as the measurement with the least number of significant figures.

Rule: The result should be rounded to the least number of significant figures in the numbers being multiplied or divided.

Example:

Calculate 4.56×1.4.

- Step 1: Identify significant figures:
- 4.56 has three significant figures.
- 1.4 has two significant figures.

- Step 2: The least number of significant figures is two (from 1.4).

- Step 3: Perform the calculation:
$$
4.56 \times 1.4 = 6.384
$$

- Step 4: Round to two significant figures:
$$
\text{Final result} = 6.4
$$

Complex Calculations Involving Both Addition/Subtraction and Multiplication/Division

In more complex scenarios involving both addition/subtraction and multiplication/division, it is essential to follow the order of operations while maintaining significant figures.

Example:

Calculate $(2.5 + 3.45) \times 1.2$.

- Step 1: Calculate the sum:
$$
2.5 + 3.45 = 5.95
$$
- The result has two decimal places (from 2.5).

- Step 2: Round the sum to two decimal places:
$$
\text{Rounded sum} = 5.95 \text{ (no change needed)}
$$

- Step 3: Multiply the rounded sum by 1.2:
$$
5.95 \times 1.2 = 7.14
$$

- Step 4: Identify significant figures:
- 5.95 has three significant figures.
- 1.2 has two significant figures.

- Step 5: The least number of significant figures is two (from 1.2).
Therefore, round 7.14 to two significant figures:
$$
\text{Final result} = 7.1
$$

Common Mistakes in Significant Figures Calculations

Mistakes in significant figures calculations can lead to misinterpretations of data and results. Here are some common pitfalls:

- **Ignoring Decimal Places:** Failing to consider the number of decimal places in addition or subtraction.
- **Overlooking Leading Zeros:** Counting leading zeros as significant figures.
- **Misapplying Rounding Rules:** Not rounding correctly based on the least number of significant figures.
- **Confusing Decimal and Whole Numbers:** Not recognizing the significance of zeros in whole numbers without a decimal point.

Answer Key to Examples

Here’s a summary of the calculations provided in the examples:

1. Result of $12.11 + 0.3 + 1.234$ is 13.6.
2. Result of 4.56×1.4 is 6.4.
3. Result of $(2.5 + 3.45) \times 1.2$ is 7.1.

Conclusion

Understanding and correctly applying significant figures in calculations is essential for accurate scientific communication. By adhering to the rules for addition, subtraction, multiplication, and division, you can ensure that your results accurately reflect the precision of your measurements. This knowledge not only enhances the integrity of your calculations but also fosters clearer communication in scientific discussions. Remember to always be diligent in identifying significant figures and rounding correctly to maintain the credibility of your work.

Frequently Asked Questions

What are significant figures and why are they important in calculations?

Significant figures are the digits in a number that contribute to its precision, including all non-zero digits, any zeros between significant

digits, and trailing zeros in a decimal number. They are important because they convey the reliability of measurements and ensure that calculations reflect the precision of the data used.

How do you determine the number of significant figures in a given measurement?

To determine the number of significant figures, count all non-zero digits, any zeros between significant digits, and trailing zeros in decimal numbers. Leading zeros are not counted as significant figures.

What are the rules for rounding when performing calculations with significant figures?

When rounding, if the digit to be dropped is less than 5, round down; if it is 5 or greater, round up. In addition, the final result should have the same number of significant figures as the measurement with the least number of significant figures used in the calculation.

In multiplication and division, how do you apply significant figures to the final answer?

In multiplication and division, the final answer should have the same number of significant figures as the measurement with the least number of significant figures involved in the calculation.

Can you provide an example of a calculation using significant figures?

Sure! If you multiply 2.5 (2 significant figures) by 3.42 (3 significant figures), the product is 8.55. However, since 2.5 has the least number of significant figures (2), the final answer should be rounded to 8.6 (2 significant figures).

Calculations Using Significant Figures Answer Key

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