

Significant Figures

When we obtain a reading from a measuring instrument we are expected to estimate a digit for the last decimal place. Hence when we read a mass from a high form triple beam balance, we record a mass measurement as 13.783 g, even though the smallest division on the balance is the hundredth's place. For this measurement, **all** of the digits are significant and we say that it contains **five** significant figures.

1. Adding and Subtracting:

When adding or subtracting numbers, the number of significant figures in the answer will agree with the precision of the data, i.e., the last decimal place which contains a significant digit. When the numbers 1.32 g and 29.2 g are added, the sum reflects the precision of the **least** precise number, the 29.2 g measure:

$$\begin{array}{r} \text{so} \quad 1.32 \text{ g} \\ + 29.2 \text{ g} \\ \hline 30.52 \text{ g which is rounded to } 30.5 \text{ g.} \end{array}$$

We round off the answer to the last full column of digits, in this case the tenths column. This rule is also true for subtraction:

$$\begin{array}{r} 27.385 \text{ g} \\ - 21.285 \text{ g} \\ \hline 6.100 \text{ g} \end{array}$$

The presence of zeros in the two columns on the right indicates that the difference has the same precision as the data from which it was obtained. To write 26.1 g, we would be using a much less precise number and would falsely indicate the precision of the measuring instrument.

2. Multiplying and Dividing:

The method of extracting significant figures from multiplication and division is different from addition and subtraction. In general, the product or quotient should have the same number of significant figures as the least precise measurement. The following table provides a few samples:

| <u>PROBLEM</u> | <u>SIGNIFICANT FIGURES in ANSWER</u> |
|--|---|
| 6.19 x 2.8 | 2 |
| 3.18 / 1.702 | 3 |
| (4.10 x 3.02 x 10 ⁹) / 1.5 | 2 |
| (6.023 x 10 ²³)(1.35) | 3 |
| 103.4 x $\sqrt{49.6}$ | 3 |

Determining the Number of Significant Figures in a Number

| <u>Sample Number</u> | <u># of Significant Figures</u> | <u>Explanation</u> |
|-----------------------|---------------------------------|---|
| 704 cm | 3 | Decimal point after 4 is understood: the next number is unknown. |
| 704.0 cm | 4 | Second zero indicates that the measurement is made to the nearest tenth of a centimeter. |
| 0.70400 cm | 5 | First zero is used only to clarify the position of the decimal point. |
| 0.000704 cm | 3 | First four zeros only locate the decimal point. |
| 7.04×10^5 cm | 3 | If written as 704,000, the last three zeros only locate the decimal point. |
| 265.43 cm | 5 | No numerals are used to locate the decimal point. |
| 8.900 cm | 4 | Last two zeros are not used to locate decimal point; they actually indicate the certainty of the measurement. |
| 60,500 cm | at least 3 | If the measurement was made to the nearest cm, then there should be five significant figures indicated. This is best written as 6.0500×10^4 cm. At worst, if this measurement was made to the nearest 100 cm, it should be reported with three significant figures as 6.05×10^4 cm. |