

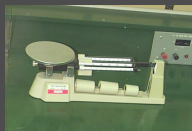
Significant Figures in Measurement

Uncertainty in Measurement

A digit that must be **estimated** is called **uncertain**. A **measurement** always has some degree of uncertainty.

Why Is there Uncertainty?

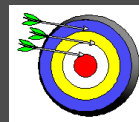
- ❖ Measurements are performed with instruments
 - ❖ No instrument can read to an infinite number of decimal places
- Which of these balances has the greatest uncertainty in measurement?



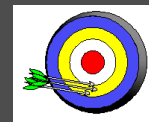
Precision and Accuracy

Accuracy refers to the agreement of a particular value with the **true** value.

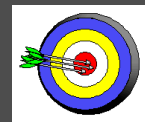
Precision refers to the degree of agreement among several measurements made in the same manner.



Neither
accurate nor
precise



Precise but not
accurate



Precise AND
accurate

Types of Error

Random Error (Indeterminate Error) - measurement has an equal probability of being high or low.

Systematic Error (Determinate Error) - Occurs in the **same direction** each time (high or low), often resulting from poor technique or incorrect calibration.

Rules for Counting Significant Figures

Nonzero integers

1) All digits 1-9 are significant.

3456 has
4 sig figs.

Rules for Counting Significant Figures - Details

Zeros

Captive zeros

- 2) Zeros between significant digits are always significant.

16.07 has
4 sig figs.

Rules for Counting Significant Figures - Details

Zeros

Trailing zeros

- 3) Trailing zeros are significant only if the number contains a decimal point anywhere in the number.

9.300 has
4 sig figs.

Rules for Counting Significant Figures - Details

Zeros

Leading zeros

- 4) Zeros in the beginning of a number whose only function is to place the decimal point are not significant.

0.0486 has
3 sig figs.

Rules for Counting Significant Figures - Details

Exact numbers have an infinite number of significant figures.

1 inch = 2.54 cm, exactly

Sig Fig Practice #1

How many significant figures in each of the following?

1.0070 m → **5 sig figs**

17.10 kg → **4 sig figs**

100,890 L → **5 sig figs**

3.29 × 10³ s → **3 sig figs**

0.0054 cm → **2 sig figs**

3,200,000 → **2 sig figs**

Significant Figures in Measurement

Part 2

Sig Fig Rules Review

- All digits 1-9 inclusive are significant.
Example: 129 has 3 significant figures.
- Zeros between significant digits are always significant.
Example: 5,007 has 4 significant figures.
- 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.
- 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.
- Zeros following a decimal significant figure are significant.
Example: 0.000470 has 3 significant figures.
0.47000 has 5 significant figures.

Rules for Significant Figures in Mathematical Operations

Multiplication and Division: # sig figs in the answer must equal the number of sig figs in the least precise measurement used in the calculation.

$$6.38 \times 2.0$$

$$= 12.76$$

13 (2 sig figs)

Sig Fig Practice #2

Calculation	Calculator says:	Answer
$3.24 \text{ m} \times 7.0 \text{ m}$	22.68 m ²	23 m ²
$100.0 \text{ g} \div 23.7 \text{ cm}^3$	4.219409283 g/cm ³	4.22 g/cm ³
$0.02 \text{ cm} \times 2.371 \text{ cm}$	0.04742 cm ²	0.05 cm ²
$710 \text{ m} \div 3.0 \text{ s}$	236.6666667 m/s	240 m/s
$1818.2 \text{ lb} \times 3.23 \text{ ft}$	5872.786 lb-ft	5870 lb-ft
$1.030 \text{ g} \div 2.87 \text{ mL}$	0.358886017 g/mL	0.359 g/mL

Rules for Significant Figures in Mathematical Operations

Addition and Subtraction: The number of decimal places in the result equals the least number of decimal places in the least precise measurement.

$$6.8 + 11.934 =$$

$$18.734$$

→ 18.7 (3 sig figs)

Sig Fig Practice #3

Calculation	Calculator says:	Answer
$3.24 \text{ m} + 7.0 \text{ m}$	10.24 m	10.2 m
$100.0 \text{ g} - 23.73 \text{ g}$	76.27 g	76.3 g
$0.02 \text{ cm} + 2.371 \text{ cm}$	2.391 cm	2.39 cm
$713.1 \text{ L} - 3.872 \text{ L}$	709.228 L	709.2 L
$1818.2 \text{ lb} + 3.37 \text{ lb}$	1821.57 lb	1821.6 lb
$2.030 \text{ mL} - 1.870 \text{ mL}$	0.16 mL	0.160 mL

Sig Fig Rules Review

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Example: 5,007 has 4 significant figures.
- 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.
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The End