

Chapter 2 : Analyzing Data

Section 3 Notes

Uncertainty in Data

Section 2-3

- **Accuracy** refers to how close a measured value is to an accepted value.
- **Precision** refers to how close a series of measurements

Accurate



An arrow in the center indicates high accuracy.

Accurate and precise



Arrows in the center indicate high accuracy. Arrows close together indicate high precision.

Precise but not accurate



Arrows far from the center indicate low accuracy. Arrows close together indicate high precision.

Not accurate or precise



Arrows far from the center indicate low accuracy. Arrows far apart indicate low precision.

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- **Error** is defined as the difference between and experimental value and an accepted value.

Table 2.3	Student Density and Error Data (Unknown was sucrose; density = 1.59 g/cm ³)					
	Student A		Student B		Student C	
	Density	Error (g/cm ³)	Density	Error (g/cm ³)	Density	Error (g/cm ³)
Trial 1	1.54 g/cm ³	-0.05	1.40 g/cm ³	-0.19	^a 1.70 g/cm ³	+0.11
Trial 2	1.60 g/cm ³	+0.01	1.68 g/cm ³	+0.09	1.69 g/cm ³	+0.10
Trial 3	1.57 g/cm ³	-0.02	1.45 g/cm ³	-0.14	1.71 g/cm ³	+0.12
Average	^b 1.57 g/cm ³		1.51 g/cm ³		1.70 g/cm ³	

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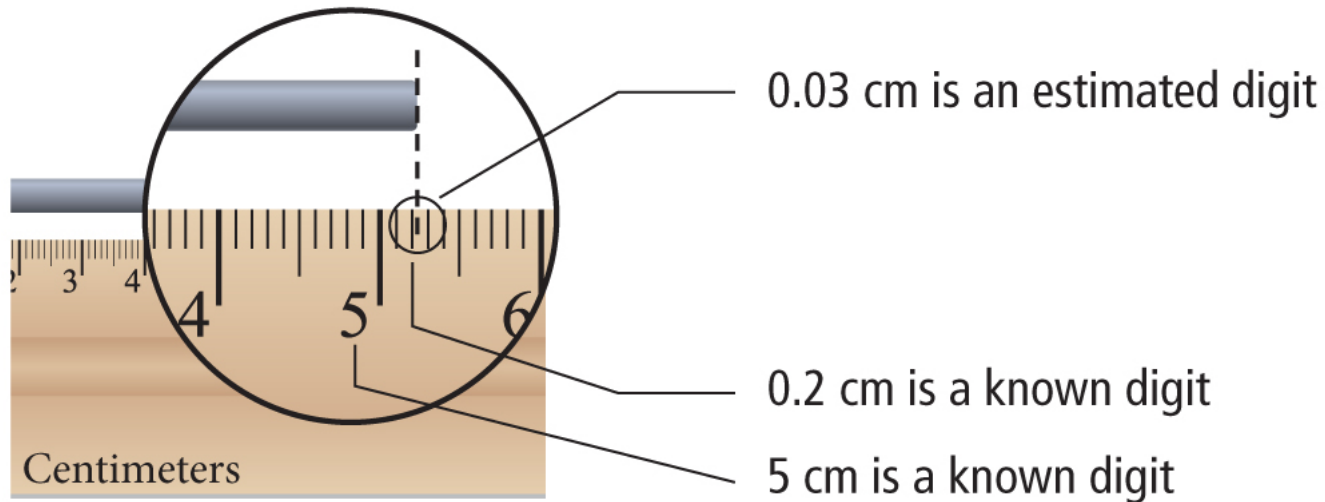
- The error equation is
error = experimental value – accepted value.
- Percent error expresses error as a percentage of the accepted value.

$$\text{percent error} = \frac{|\text{error}|}{\text{accepted value}} \times 100$$

Significant Figures

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- Often, precision is limited by the tools available.
- Significant figures include all known digits plus one estimated digit.



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- **Rules for significant figures**
 - **Rule 1:** Nonzero numbers are always significant.
 - **Rule 2:** Zeros between nonzero numbers are always significant.
 - **Rule 3:** All final zeros to the right of the decimal are significant.
 - **Rule 4:** Placeholder zeros are not significant. To remove placeholder zeros, rewrite the number in scientific notation.
 - **Rule 5:** Counting numbers and defined constants have an infinite number of significant figures.

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- Calculators are not aware of significant figures.
- Answers should not have more significant figures than the original data with the fewest figures, and should be rounded.

Rounding Numbers (cont.) Section 2-3

- **Rules for rounding**

- **Rule 1:** If the digit to the right of the last significant figure is less than 5, do not change the last significant figure.
- **Rule 2:** If the digit to the right of the last significant figure is greater than 5, round up to the last significant figure.
- **Rule 3:** If the digits to the right of the last significant figure are a 5 followed by a nonzero digit, round up to the last significant figure.

Rounding Numbers (cont.) Section 2-3

- **Rules for rounding (cont.)**
 - **Rule 4:** If the digits to the right of the last significant figure are a 5 followed by a 0 or no other number at all, look at the last significant figure. If it is odd, round it up; if it is even, do not round up.

Rounding Numbers (cont.) Section 2-3

- **Addition and subtraction**
 - Round numbers so all numbers have the same number of digits to the right of the decimal.
- **Multiplication and division**
 - Round the answer to the same number of significant figures as the original measurement with the fewest significant figures.