Section 2.3 Uncertainty in Data

Objectives

- **Define** and compare accuracy and precision.
- **Describe** the accuracy of experimental data using error and percent error.
- **Apply** rules for significant figures to express uncertainty in measured and calculated values.

Review Vocabulary

experiment: a set of controlled observations that test a hypothesis

Section 2.3 Uncertainty in Data (cont.)

New Vocabulary

accuracy

percent error

precision

significant figures

error

Measurements contain uncertainties that affect how a result is presented.

- Qualitative Vs. Quantitative Data
- Qualitative Data is based on observations and judgements (Quality)
  - Ex) Color, Texture, Approximations

- Quantitative Data is based on actual measurements.
  - Ex) Temp., Length, Mass, Density

Accuracy and Precision

- **Accuracy** refers to how close a measured value is to an accepted value.

- **Precision** refers to how close a series of measurements are to one another.

Accurate

An arrow in the center indicates high accuracy.

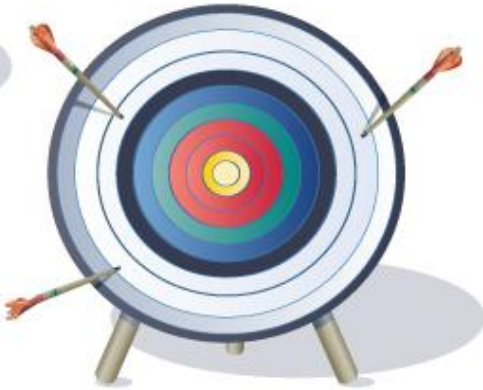
Precise but not accurate

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

Accurate and precise

Arrows in the center indicate high 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.

Concepts In Motion

Click here to view an animated version of this graphic.

- EXAMPLES
- If we measure the length of a foot-ruler and get values of
- 12.01 in, 12.00 in, 11.99 in, 12.00 in.
- These numbers are precise enough for us to believe that if we measure it again we would get 12.00+0.01 in. These measurements are precise but necessarily accurate. The foot-ruler may actually be metric ruler of 30.0 cm long. Our measurement is precise but not accurate.

- Here's another example: The TV weather forecaster says that it will be between 40 and 60 degrees today. The actual reading turns out to be 53. Thus, the forecast was *accurate,* but not very *precise.* The forecaster provided a true statement but without enough detail for us to make plans.
- For tomorrow, the forecast is 52.47 degrees at 4 PM. It turns out to be 61 degrees. This forecast was very *precise,* but completely *inaccurate.*

Accuracy and Precision (cont.)

- **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/cm³)

	Student A		Student B		Student C	
	Density	Error (g/cm³)	Density	Error (g/cm³)	Density	Error (g/cm³)
Trial 1	1.54 g/cm³	−0.05	1.40 g/cm³	−0.19	(a) 1.70 g/cm³	+0.11
Trial 2	1.60 g/cm³	+0.01	1.68 g/cm³	+0.09	1.69 g/cm³	+0.10
Trial 3	1.57 g/cm³	−0.02	1.45 g/cm³	−0.14	1.71 g/cm³	+0.12
Average	(b) 1.57 g/cm³		1.51 g/cm³		1.70 g/cm³	

Accuracy and Precision (cont.)

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

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

Ex) % Error problem

- If the accepted mass of a piece of weighing paper is 1.24 g, but you obtain a experimental result of 1.21 g, what is the percent error of the experiment?

$$|1.21 - 1.24| = .03$$

$$\frac{.03}{1.24} = .024 \text{ or } 2.4\%$$

Ex) % Error problem

- If the accepted height of a piece of student's height 180.34 cm, but you obtain a experimental result of 178.90 g, what is the percent error of the experiment?

$$|178.90 - 180.34| = 1.44$$

$$\frac{1.44}{180.34} = 0.008 \text{ or } 0.8\ \%$$

Study Guide Section 2.3 Uncertainty in Data

Key Concepts

- An accurate measurement is close to the accepted value. A set of precise measurements shows little variation.
- The measurement device determines the degree of precision possible.
- Error is the difference between the measured value and the accepted value. Percent error gives the percent deviation from the accepted value.

$$\text{error} = \text{experimental value} - \text{accepted value}$$

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

Section 2.3 Assessment

CheckPoint

A substance has an accepted density of 2.00 g/L. You measured the density as 1.80 g/L. What is the percent error?

A. 20%

B. –20%

C. 10%

D. 90%