Units and Measurements

Example Problems on Precision and Accuracy

Example Problem 1

Problem:
A scientist measures the length of a metal rod five times and obtains the following measurements in centimeters: 50.1 cm, 50.2 cm, 50.1 cm, 50.3 cm, and 50.2 cm. The true length of the rod is 50.0 cm. Determine the precision and accuracy of these measurements.

Solution:

1. **Calculate the Mean**:

$$\text{Mean} = \frac{50.1 + 50.2 + 50.1 + 50.3 + 50.2}{5} = 50.18 \text{ cm}$$

2. **Determine Precision**:
   The measurements are close to each other (50.1 cm to 50.3 cm), indicating high precision.

3. **Determine Accuracy**:
   The mean measurement (50.18 cm) is close to the true value (50.0 cm), but not exact. Thus, the measurements are slightly less accurate but fairly close.

Example Problem 2

Problem:
A student measures the mass of a 100 g standard weight three times and gets the following results: 98 g, 97 g, and 99 g. Determine the precision and accuracy of these measurements.

Solution:

1. **Calculate the Mean**:

$$\text{Mean} = \frac{98 + 97 + 99}{3} = 98 \text{ g}$$

2. **Determine Precision**:
   The measurements are close to each other (97 g to 99 g), indicating moderate precision.

3. **Determine Accuracy**:
   The mean measurement (98 g) is close to the true value (100 g), indicating moderate accuracy.

Practice Problems

1. A researcher measures the boiling point of water three times and records 101.2°C, 101.3°C, and 101.1°C. The true boiling point is 100.0°C. Determine the precision and accuracy of these measurements.

2. A chemist measures the volume of a liquid sample four times and gets 25.5 mL, 25.6 mL, 25.5 mL, and 25.4 mL. The true volume is 25.0 mL. Determine the precision and accuracy of these measurements.

3. An engineer measures the width of a metal plate five times and records 12.0 cm, 12.1 cm, 12.0 cm, 12.2 cm, and 12.0 cm. The true width is 12.0 cm. Determine the precision and accuracy of these measurements.

4. A physicist measures the time period of a pendulum five times and gets 2.05 s, 2.03 s, 2.04 s, 2.02 s, and 2.04 s. The true time period is 2.00 s. Determine the precision and accuracy of these measurements.

5. A student measures the density of a metal sample three times and obtains 8.9 g/cm^3, 9.0 g/cm^3, and 8.8 g/cm^3. The true density is 8.5 g/cm^3. Determine the precision and accuracy of these measurements.

6. A technician measures the resistance of a resistor four times and gets 100.2 Ω, 100.1 Ω, 100.3 Ω, and 100.2 Ω. The true resistance is 100.0 Ω. Determine the precision and accuracy of these measurements.

7. An experimenter measures the height of a plant four times and records 15.1 cm, 15.0 cm, 15.2 cm, and 15.1 cm. The true height is 15.0 cm. Determine the precision and accuracy of these measurements.

8. A biologist measures the pH of a solution three times and gets 7.1, 7.2, and 7.1. The true pH is 7.0. Determine the precision and accuracy of these measurements.

9. A surveyor measures the length of a field five times and records 100.0 m, 100.1 m, 99.9 m, 100.2 m, and 100.0 m. The true length is 100.0 m. Determine the precision and accuracy of these measurements.

10. A geologist measures the weight of a rock sample four times and gets 250 g, 249 g, 251 g, and 250 g. The true weight is 250 g. Determine the precision and accuracy of these measurements.

Key

10. Mean: 250 g; Precision: High; Accuracy: high

1. **Mean**: 101.2°C; **Precision**: High; **Accuracy**: Low
2. **Mean**: 25.5 mL; **Precision**: High; **Accuracy**: Low
3. **Mean**: 12.06 cm; **Precision**: High; **Accuracy**: High
4. **Mean**: 2.036 s; **Precision**: High; **Accuracy**: Moderate
5. **Mean**: 8.9 g/cm^3; **Precision**: Moderate; **Accuracy**: Low
6. **Mean**: 100.2 Ω; **Precision**: High; **Accuracy**: High
7. **Mean**: 15.1 cm; **Precision**: High; **Accuracy**: High
8. **Mean**: 7.13; **Precision**: High; **Accuracy**: Low
9. **Mean**: 100.04 m; **Precision**: High; **Accuracy**: High

10. **Mean**: 250 g; **Precision**: High; **Accuracy**: High