

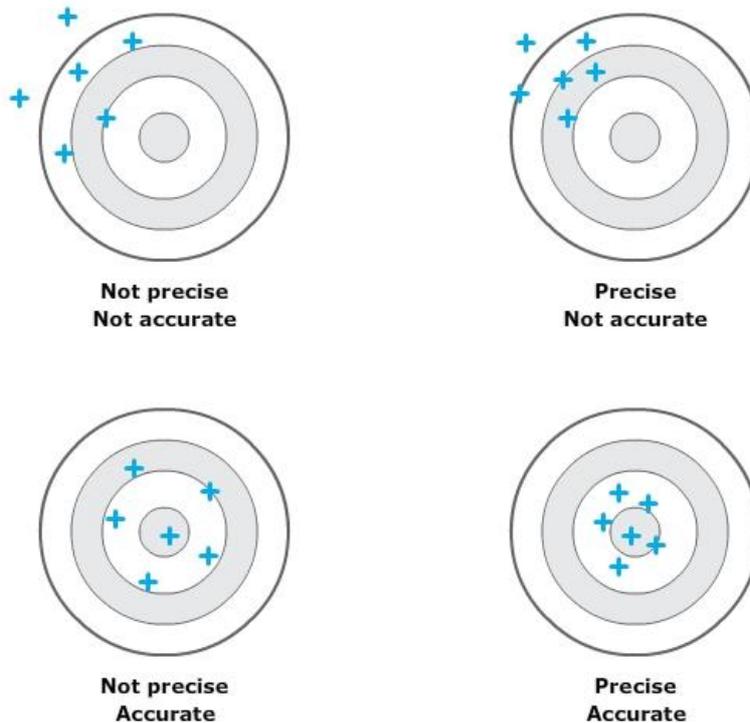
Analysing data:

NAME, DATE, SECTION

When taking scientific measurements, the goals are to measure accurately and with precision.

- Accuracy indicates the closeness of the measurements to the true or accepted value.
- Precision is the closeness of the results to others obtained in exactly the same way.

In this image, the bull's-eye represents the accepted true value. Each cross represents a repeated measurement of the same quantity.



In certain situations in the laboratory, you may be measuring a quantity that has an accepted value. The difference between the measured result and the accepted value is the error in the result.

- error = measured value - accepted value
- % error = (error in measurement/accepted value) x 100

For example, the accepted value for the mass of a new golf ball is 45.93 g. A student weighs a golf ball and finds it to be 46.45 g. The % error is:

$$\begin{aligned} \% \text{ error} &= (\text{error in measurement}/\text{accepted value}) \times 100 \\ &= [(46.45 - 45.93)/45.93] \times 100 \\ &= [0.52/45.93] \times 100 \\ &= 1.13\% \end{aligned}$$

Rather than measuring once, it is common practice to take a number of separate measurements. This eliminates any 'outlier' results (results that do not fit the expected outcome) and allows for an average value to be taken.

For example, a student weighs a golf ball on five separate occasions, and the results are: 45.89 g, 45.91 g, 46.06 g, 36.98 g and 45.94 g. On looking carefully at the results, it is clear that the result '36.98 g' does not fit in with the other results. It is an 'outlier' and is discarded.

The average mass is calculated as:
 $(45.89 + 45.91 + 46.06 + 45.94)/4 = 45.95 \text{ g}$



Coin diameter

A gold coin has an 'accepted' diameter of 28.054 mm.

Two students are asked to measure the diameter of four gold coins. Student A uses a simple plastic ruler. Student B uses a precision measuring tool called a micrometer.

Student A – plastic ruler	Student B – micrometer
27.9 mm	28.246 mm
28.0 mm	28.244 mm
27.8 mm	28.246 mm
28.1 mm	28.248 mm

1. Calculate the average value for each set of measurements

Student A – plastic ruler	Student B – micrometer

2. Calculate the % error for each set of measurements.
(Measured value – Accepted Value) divided by Accepted Value times 100.

Student A – plastic ruler	Student B – micrometer

3. Compare the average value for each set with the accepted value:

- Which student's data is more accurate?
- Which student's data is more precise?

4. Compare the percentage error for each set:

- Which student's data is more accurate?
- Which student's data is more precise?

5. Explain any odd findings:

Aluminium bar density

Two students are given a small cylinder of aluminium of known mass and asked to determine its density. (The 'accepted' density of aluminium is 2.702 g/cm^3 .) Since density is mass/volume, the students need to calculate the volume of the cylinder. To do this, the height and diameter of the cylinder need to be measured.

Student A is told to use a simple plastic ruler and to make four independent measurements for each dimension. Student B is told to use a precision measuring tool called a micrometer.

Student A – plastic ruler	Student B – micrometer
2.2 g/cm^3	2.703 g/cm^3
2.3 g/cm^3	2.701 g/cm^3
2.7 g/cm^3	2.705 g/cm^3
2.4 g/cm^3	5.811 g/cm^3

1. Calculate the average value for each set of density values, making sure that any 'outliers' are not included.

Student A – plastic ruler	Student B – micrometer

2. Calculate the % error for each set of values.
(Measured value – Accepted Value) divided by Accepted Value times 100.

Student A – plastic ruler	Student B – micrometer

3. Compare the average value for each set with the accepted value:

- Which student's data is more accurate?
- Which student's data is more precise?

4. Compare the percentage error for each set:

- Which student's data is more accurate?
- Which student's data is more precise?

5. Explain any odd findings: