Accuracy & Precision

Unit: Laboratory & Measurement

NGSS Standards: N/A

MA Curriculum Frameworks (2006): N/A

AP Physics 1 Learning Objectives: N/A

Knowledge/Understanding:

- Understand what accuracy and precision mean and the difference between the two.

Language Objectives:

- Understand and be able to differentiate between accuracy and precision.

Notes:

Science relies on making and interpreting measurements, and the accuracy and precision of these measurements affect what you can conclude from them.

Random vs. Systematic Errors

Random errors are natural uncertainties in measurements because of the limits of precision of the equipment used. Random errors are assumed to be distributed around the actual value, without bias in either direction. Systematic errors occur from specific problems in your equipment or your procedure. Systematic errors are often biased in one direction more than another, and can be difficult to identify.

Accuracy vs. Precision

The words “accuracy” and “precision” have specific meanings in science.

accuracy: for a single measurement, how close the measurement is to the “correct” or accepted value. For a group of measurements, how close the average is to the accepted value. Poor accuracy is often an indication of systematic error.

precision: for a single measurement, how finely the measurement was made. (How many decimal places it was measured to.) For a group of measurements, how close the measurements are to each other. Poor precision tends to cause larger random error.

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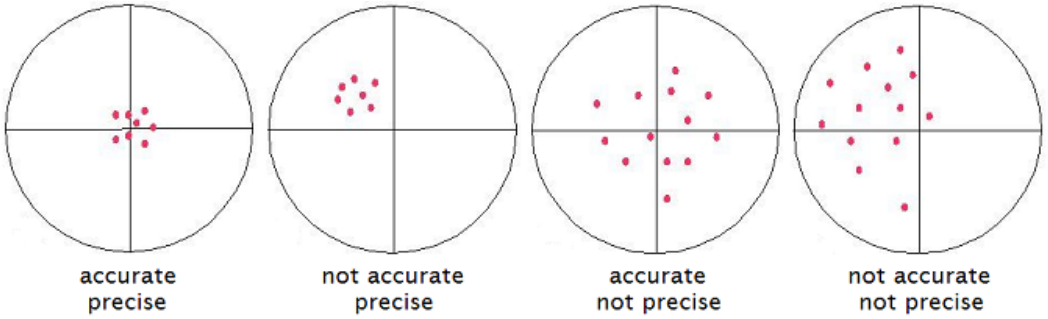
Examples:

Suppose the following drawings represent arrows shot at a target.



The first set is both accurate (the average is close to the center) and precise (the data points are all close to each other.)

The second set is precise (close to each other), but not accurate (the average is not close to the correct value). This is an example of *systemic* error—some problem with the experiment caused all of the measurements to be off in the same direction.

The third set is accurate (the average is close to the correct value), but not precise (the data points are not close to each other). This is an example of *random* error—the measurements are not biased in any particular direction, but there is a lot of scatter.

The fourth set is neither accurate nor precise, which means that there are significant random and systematic errors present.

For another example, suppose two classes estimate Mr. Bigler's age. The first class's estimates are 73, 72, 77, and 74 years old. These measurements are fairly precise (close together), but not accurate. (Mr. Bigler is actually about 51 years old.) The second class's estimates are 0, 1, 97 and 98. This ***set*** of data is accurate (because the average is 49, which is close to correct), but the ***set*** is not precise because the individual values are not close to each other.

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