

Unit 2 • What Can We Measure About Chemicals?

ANSWERS to ACCURACY & PRECISION

Idea 1: Measurements (3.25 cm) are different than other numbers (3.14159265).

- Measurements represent an action by someone with some measuring instrument.
- Measurements have built-in uncertainty; no measurement is exact.
- Measurements have units.

Idea 2: The uncertainty in a measurement needs to be communicated.

Definitions:

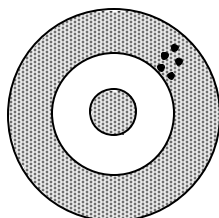
accuracy – how close a measurement is to the “true” or accepted value

precision – how close a measurement is to the other measurements

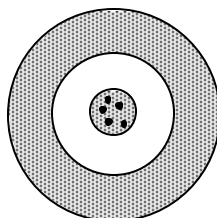
Precision versus Accuracy:

Look at each target below and decide whether the situation is accurate, precise, both, or neither:

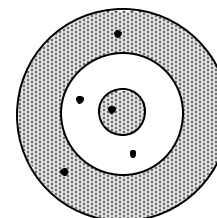
(Note: it is “accepted” that the bull’s eye is the place everyone aims for.)



Accurate?: Yes / **No**
 Precise?: **Yes** / No



Accurate?: **Yes** / No
 Precise?: **Yes** / No



Accurate?: Yes / **No**
 Precise?: Yes / **No**

Precision Problems:

Several lab groups measure the density of aluminum. Here is their data:

Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7
2.65 g/cm ³	2.75 g/cm ³	2.80 g/cm ³	2.77 g/cm ³	2.60 g/cm ³	2.65 g/cm ³	2.68 g/cm ³

What is the average density? 2.70 g/cm³

Subtract the highest value from the lowest value: 0.20 Divide this number by 2: 0.10

The precision of the measurement can be shown as 2.70 ± 0.10 g/cm³.

Here is more data. Is this more precise, less precise, or the same precision as the above data? same

Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7
2.60 g/cm ³	2.70 g/cm ³	2.80 g/cm ³	2.75 g/cm ³	2.65 g/cm ³	2.62 g/cm ³	2.78 g/cm ³

This also comes out as 2.70 ± 0.10 g/cm³, the same precision.

Accuracy Problems:

$$\% \text{ error} = \frac{\text{actual value} - \text{measured value}}{\text{actual value}} \times 100$$

1. Working in the laboratory, a student find the density of a piece of pure aluminum to be 2.85 g/cm^3 . The accepted value for the density of aluminum is 2.699 g/cm^3 . What is the student's percent error?

$$\% \text{ error} = \frac{|2.699 - 2.85|}{2.699} \times 100 = 5.59 \%$$

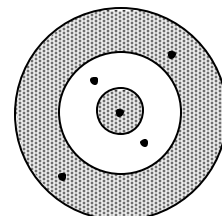
2. A student experimentally determines the specific heat of water to be $4.29 \text{ J/g} \times \text{C}^\circ$. He then looks up the specific heat of water on a reference table and finds that is is $4.18 \text{ J/g} \times \text{C}^\circ$. What is his percent error?

$$\% \text{ error} = \frac{|4.18 - 4.29|}{4.18} \times 100 = 2.63 \%$$

3. A student takes an object with an accepted mass of 200.00 grams and masses it on his own balance. He records the mass of the object as 196.5 g. What is his percent error?

$$\% \text{ error} = \frac{|200.00 - 196.5|}{200.00} \times 100 = 1.75 \%$$

4. Often, with accuracy we are concentrating on one measurement. However, we can also look at a collection of measurements and simply take the average. Does this target represent someone who is accurate? Yes Precise? No



It is a little odd to talk about the average of some marks on a target, but you can see that the dots are matched up and down and right and left. They would, on the average, point toward the center of the target.

This would be similar to a situation in which there is random fluctuation (noise) and averaging several data values gives a good reading. Real life examples include noise reduction in audio recordings, averaging GPS (global positioning systems) readings to get a better location, or weighing small zoo animals in a stainless steel bowl and taking the average.