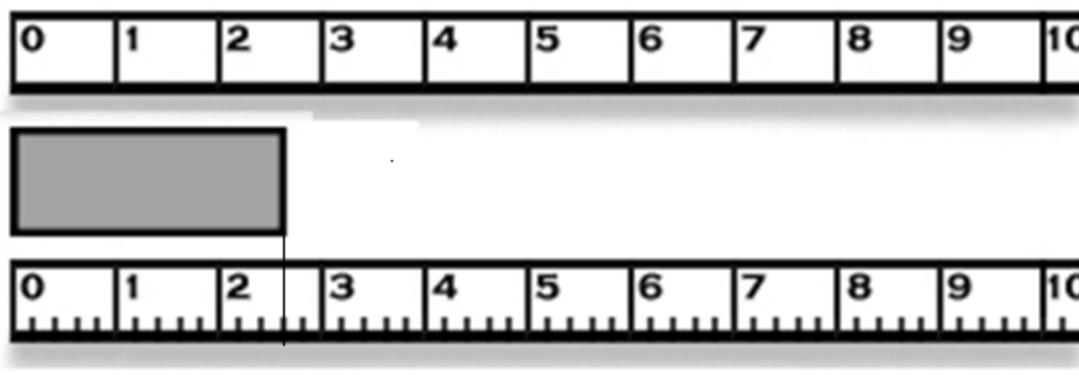


Lesson 4: Measurement and Uncertainty.

There is always some uncertainty in any measurement. Q: Why?

Consider the two scales and the shaded object below.



***Orally:** Using the upper scale, it is easy to see the object has a length greater than 2 cm but less than 3 cm. The length appears closer to 3 cm, so estimates of 2.6 cm, 2.7 cm or 2.8 cm would be reasonable. It is understood that for a measurement recorded as 2.7 cm, the last digit (7) is an estimate.*

Now consider the second scale. The measurement appears to be right on 2.6 cm, but since the smallest division is in the tenths place we still get a guess in the hundredths. Therefore we would read this as 2.60 cm.

Practice taking a few measurements with the handout “Taking measurements”

Precision and Accuracy

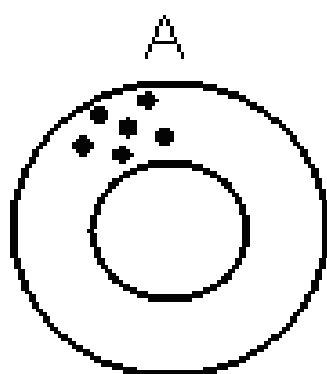
- Precision:**
- Precision is usually controlled by the size of the scale of the measuring device. A balance that can read mass to 0.0001 g is more precise than one that reads mass to 0.1 g.
 - Reproducibility of measurements (i.e., when many trials record a similar result we reduce our uncertainty)

Answer #1: A scale with more precision = less uncertainty

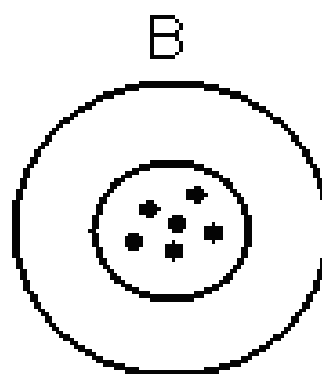
Answer#2: An experiment with more trials = less uncertainty

Answer #3: Reading uncertainty – because a guess is made, not all individuals will make the same guess (even though the place value where the guess is made is the same).

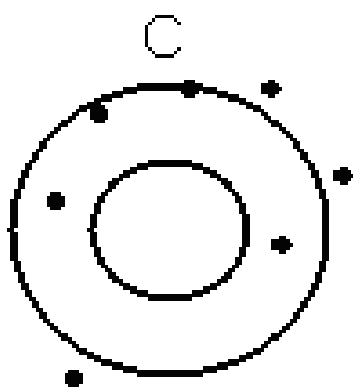
Accuracy: measures the agreement between a measurement and the accepted standard value. If a balance consistently gives a value of 3.64 g on repeated measurements, its precision is good. However, if the actual mass is 3.75 g, its accuracy is poor!



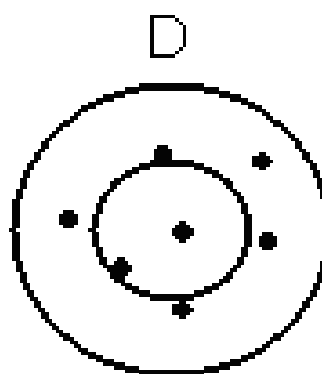
Precise
Inaccurate



Precise
Accurate



Imprecise
Inaccurate



Imprecise
Accurate

Answer #4: Not all instruments measure with the same degree of accuracy. e.g., one should expect a graduated cylinder to provide volume measurements that are more accurate than a beaker.

Q: How does one determine uncertainty (also called reading error) in a measurement?

- the uncertainty represents a range of possible values where one would expect to find the actual value.

e.g. if the actual volume of water is 32.5 mL and we measure the water at 32.4 ± 0.1 mL, the range of possible solutions lies between 32.3 and 32.5 (which includes the actual values!)

- When taking a measurement, how does one know what an appropriate amount of uncertainty (i.e., reading error) will be?

- The place value of the reading error is always the same as the place value of the estimated digit in the measurement. The digit that is selected based on the scale of the apparatus. If the scale increases by 1, use a one. If the scale increases by 2, use a two which indicates increased uncertainty in the estimated digit.

Assignment: Pg. 29 from Hebden #44 and 45 and Pg.32 #48 and 50