Accuracy & Precision in Measurement

Accuracy & Precision

- Accuracy:
  - How close you are to the actual value
  - Depends on the person measuring
  - Calculated by the formula:

% Error = (YV – AV) x 100 ÷ AV

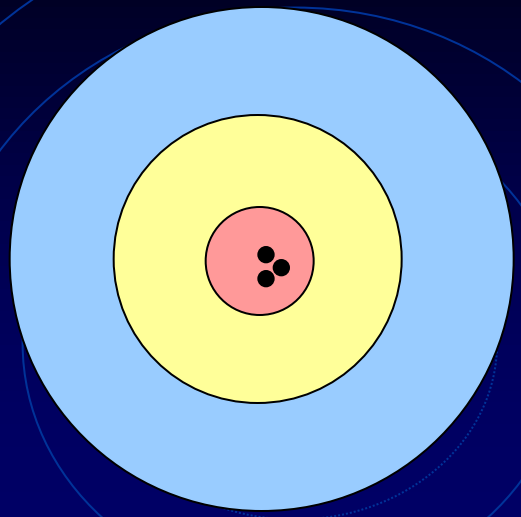
Where: YV is YOUR measured Value &
AV is the Accepted Value

- Precision:
  - How finely tuned your measurements are or how close they can be to each other
  - Depends on the measuring tool
  - Determined by the number of significant digits

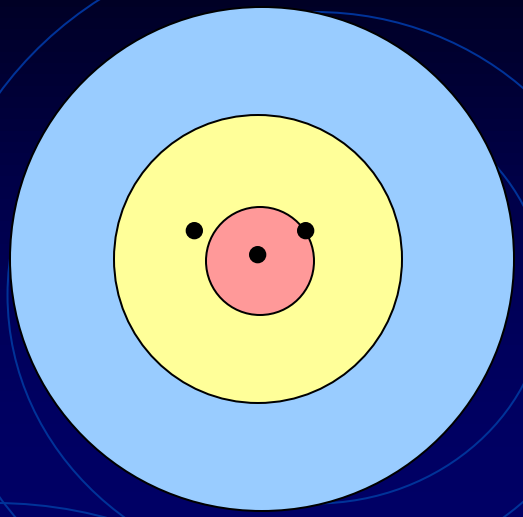
Accuracy & Precision

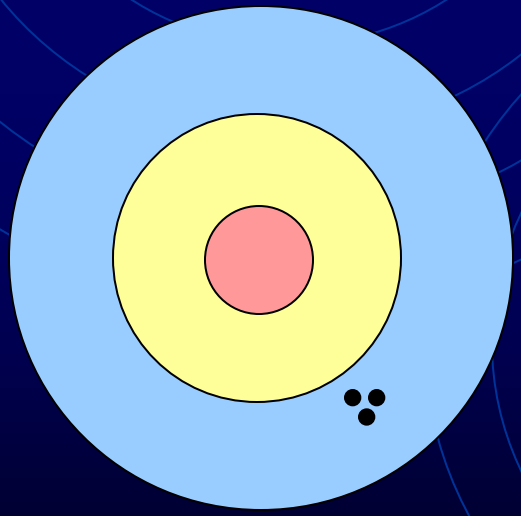
- Accuracy & Precision may be demonstrated by shooting at a target.
- Accuracy is represented by hitting the bulls eye (the accepted value)
- Precision is represented by a tight grouping of shots (they are finely tuned)

Accuracy & Precision

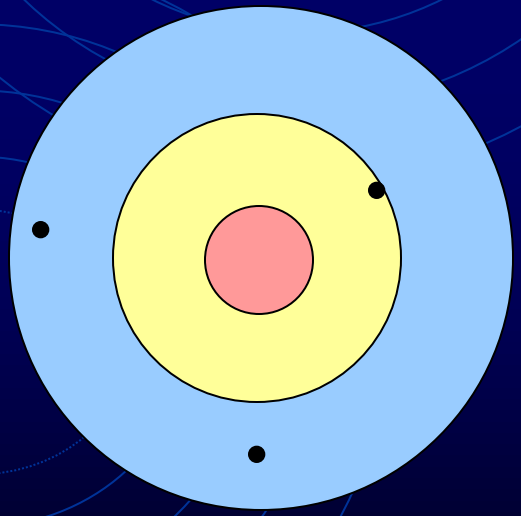


Accuracy without Precision





Precision without Accuracy



No Precision & No Accuracy

Accuracy - Calculating % Error

How Close Are You to the Accepted Value (Bull's Eye)

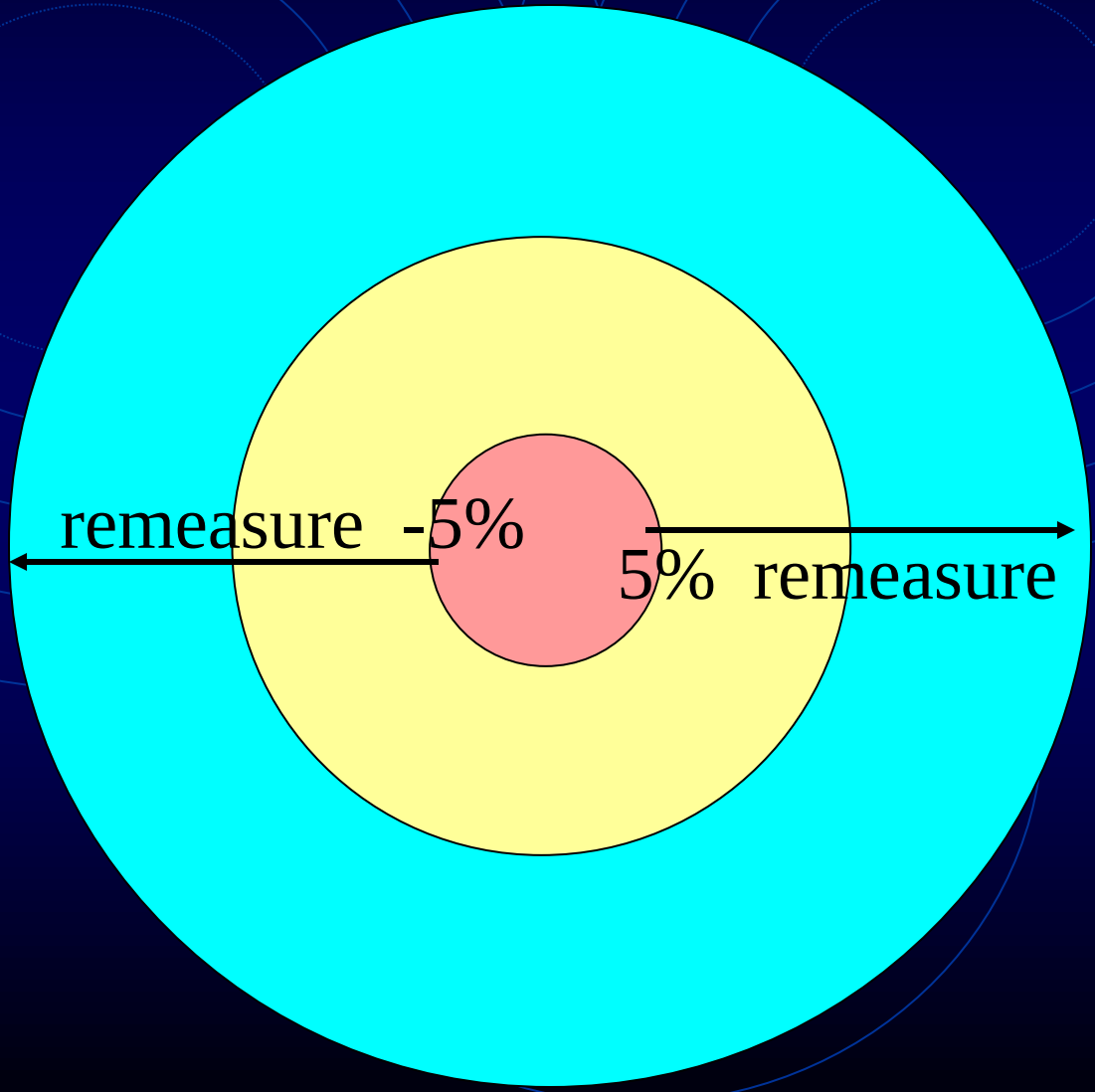
Accuracy - Calculating % Error

- If a student measured the room width at 8.46 m and the accepted value was 9.45 m what was their accuracy?
- Using the formula:
  % error = (YV – AV) x 100 ÷ AV
  - Where YV is the student's measured value & AV is the accepted value

Accuracy - Calculating % Error

- Since YV = 8.46 m, AV = 9.45 m
- % Error = (8.46 m – 9.45 m) x 100 ÷ 9.45 m
- = -0.99 m x 100 ÷ 9.45 m
- = -99 m ÷ 9.45 m
- = -10.5 %
  - Note that the meter unit cancels during the division & the unit is %. The (-) shows that YV was low
- The student was off by almost 11% & must remeasure
- Acceptable % error is within 5%

- Acceptable error is +/- 5%
  - Values from –5% up to 5% are acceptable
  - Values less than –5% or greater than 5% must be remeasured



Significant Digits

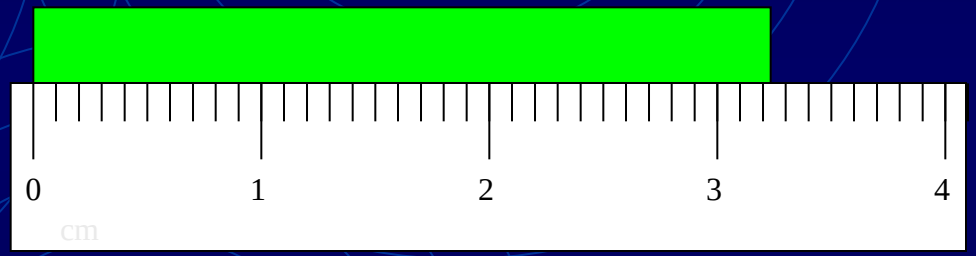
How to Check a Measurement for Precision

Significant Digits & Precision

- **The precision of a measurement is the smallest possible unit that could be measured.**
- **Significant Digits (sd) are the numbers that result from a measurement.**
- **When a measurement is converted we need to make sure we know which digits are significant and keep them in our conversion**
- **All digits that are measured are significant**

Significant Digits & Precision

- What is the length of the bar?



Length of Bar = 3.23 cm

- **How many digits are there in the measurement?**
- **All of these digits are significant**
- **There are 3 sd**

Significant Digits & Precision

- If we converted to that measurement of 3.23 cm to μm what would we get?
- Right! 32 300 μm
- How many digits in our converted number?
- Are they all significant digits (measured)?
- Which ones were measured and which ones were added because we converted?
- If we know the significant digits we can know the precision of our original measurement

Significant Digits & Precision

- What if we didn't know the original measurement – such as 0.005670 hm. How would we know the precision of our measurement.
- The rules showing how to determine the number of significant digits is shown in your lab manual on p. 19. Though you can handle them, they are somewhat complex.