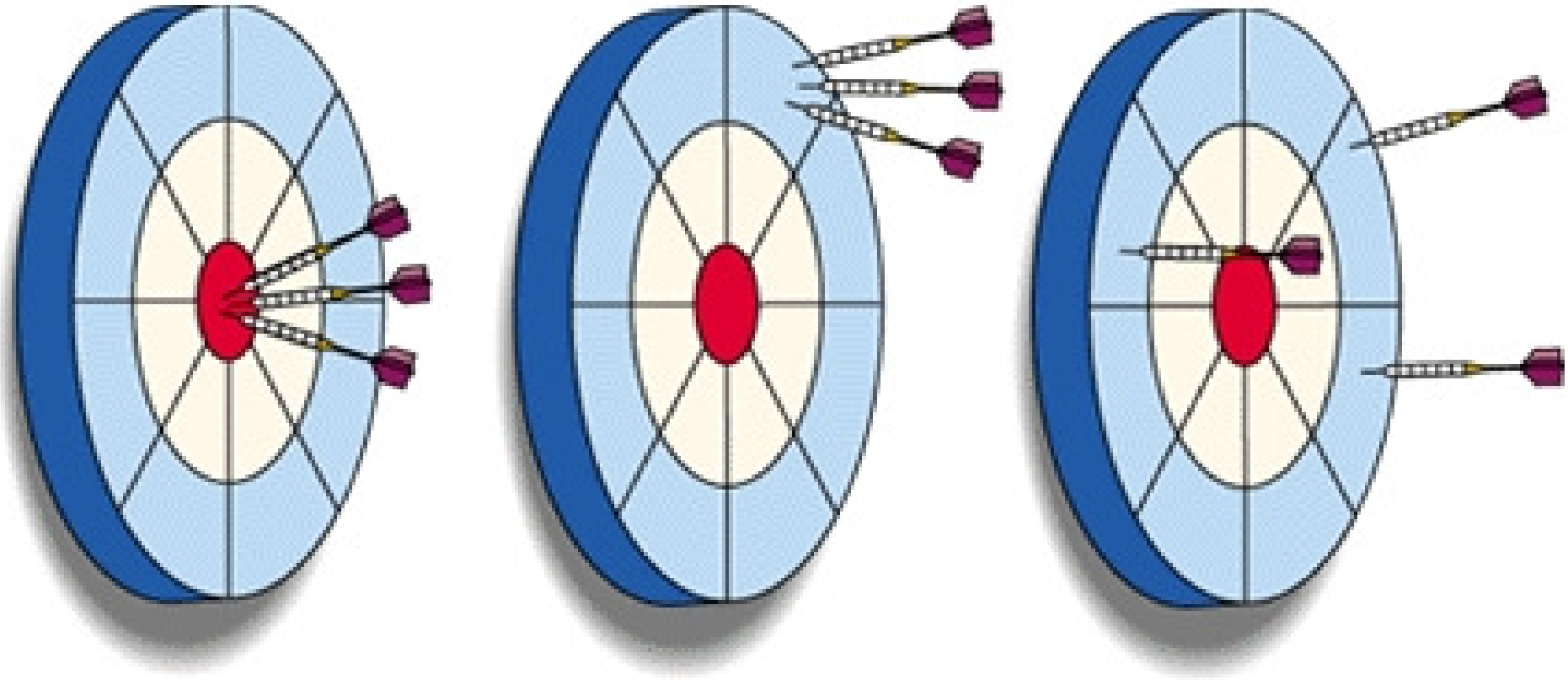
Significant Figures

Accuracy and Precision

Accuracy and Precision

- the concepts of accuracy and precision are very important to science and engineering.
- the **accuracy** of a measurement is dependent on how close that observation is to the real value.
- the **precision** of a set of measurements is associated with how carefully the measurements were obtained
- the repeatability of the measurements
- not whether they are accurate or not.

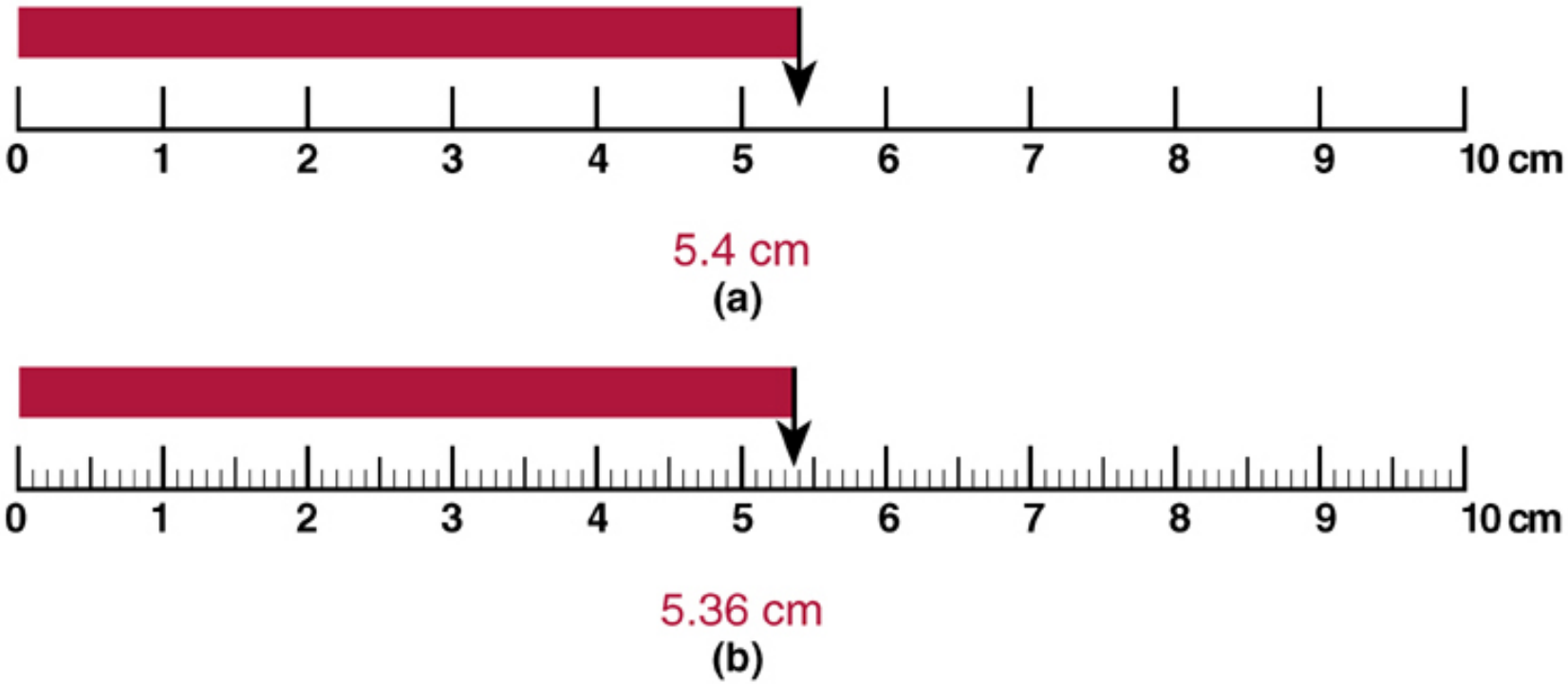


Good accuracy
Good precision

Poor accuracy
Good precision

Poor accuracy
Poor precision

Significant Figures



Significant figures - all digits in a number representing data or results that are known with certainty plus one uncertain digit.

Significant Figures

- The measuring devise determines the number of significant figures a measurement has.
- In this section you will learn
  - to determine the correct number of significant figures (sig figs) to record in a measurement
  - to count the number of sig figs in a recorded value
  - to determine the number of sig figs that should be retained in a calculation.

- For example, if you measured the length, width, and height of a block you could calculate the volume of a block:

  Length: 0.11 cm

  Width: 3.47 cm

  Height: 22.70 cm

Volume = 0.11cm x 3.47cm x 22.70cm

= 8.66459 cm^3

Where do you round off?

= 8.66? = 8.7? 8.66459?

RECOGNITION OF SIGNIFICANT FIGURES

- All nonzero digits are significant.
  - 3.51 has 3 sig figs
- The number of significant digits is independent of the position of the decimal point
- Zeros located between nonzero digits are significant
  - 4055 has 4 sig figs

Significant Figures

- Zeros at the end of a number (trailing zeros) are significant if the number contains a decimal point.
  - 5.7000 has 5 sig figs
- Trailing zeros are ambiguous if the number does not contain a decimal point
  - 2000. versus 2000
- Zeros to the left of the first nonzero integer are not significant.
  - 0.00045 (note: 4.5×10^{-4})

Examples of Significant Figures

How many significant figures are in the following?

4 7.500

4 2009

3 600.

4 0.003050

6 80.0330

Examples of Significant Figures

6	2.30900
2	0.00040
4	30.07
1,2,or 3	300
2	0.033

Significant Figures

- Exact numbers can be considered as having unlimited number of significant figures. This applies to defined quantities
- In addition and subtraction, the last digit retained in the sum or difference is determined by the position of the first doubtful digit
- In multiplication and division, an answer contains no more significant figures than the least number of significant figures used in the operation

SCIENTIFIC NOTATION & Sig Figs

- Often used to clarify the number of significant figures in a number.
- Example:

$$4{,}300 = 4.3 \times 1{,}000 = \underline{4}.\underline{3} \times 10^{3}$$

$$0.070 = 7.0 \times 0.01 = \underline{7}.\underline{0} \times 10^{-2}$$

Significant Figures

SIGNIFICANT FIGURES IN CALCULATION OF RESULTS

I. Rules for Addition and Subtraction

- The answer in a calculation cannot have greater significance than any of the quantities that produced the answer.
- example: 54.4 cm +2.02 cm

54.4 cm
2.02 cm
56.42 cm

correct answer 56.4 cm

Significant Figures

II. Rules for Multiplication and Division

- The answer can be no more precise than the least precise number from which the answer is derived.
- The least precise number is the one with the fewest sig figs.

$$\frac{4.2\times10^{3}(15.94)}{2.255\times10^{-4}} = 2.9688692\times10^{-8} \text{ (on calculator)}$$

Which number has the fewest sig figs?

The answer is therefore, 3.0 x 10^{-8}