

Measurement

Measurement

- Comparison between the unknown (measurand) and the known (reference standard).
- Both the measurand and the standard need to be clearly established.

Systeme International (S.I.)

- Length m
- Mass kg
- Time s
- Temperature K
- Electric current A
- Luminous intensity cd
- Number of particles mol

Accuracy

- Accuracy refers to how well a measurement agrees with an accepted standard.
- Accuracy refers to the exactness of a measurement.
- Error Analysis evaluates accuracy.
- $(\text{measured} - \text{accepted}) / (\text{accepted}) \times 100\%$

Precision

- Precision describes how well a measuring device can produce a measurement.
- The limit of precision depends on the design and construction of the measuring device.
- The limit of precision of a measuring device is equal to \pm one half of its smallest divisions.
- Precision describes how “tight” the measurements are among themselves.

Reliable measurements

- Reliable measurements are BOTH accurate and precise.

Bull's eye illustration

- You are throwing darts at the center point of a dartboard.
- The closeness that the darts are to the center refers to their accuracy; the “tightness” that the darts are among themselves refers to their precision.
- We want the darts to be both close to the center and also “tight” together.

Significant digits

- Significant digits are the digits that are part of any valid measurement.
- Significant digits are all of those digits that represent marked calibrations on the measuring device PLUS one additional digit to represent the estimated digit.
- Example: A meter stick provides four significant figures: three certain and one estimated.

Measuring devices and sig figures

- 0 marks: 0 certain + 1 estimate = 1 sig figures
- 1 marks: 1 certain + 1 estimate = 2 sig figures
- 2 marks: 2 certain + 1 estimate = 3 sig figures
- 3 marks: 3 certain + 1 estimate = 4 sig figures
- 4 marks: 4 certain + 1 estimate = 5 sig figures

Rules for zeroes

- 1. All non-zero digits are significant.
- 2. Zeroes are significant if bounded by non-zero digits.
- 3. If a decimal point is used, all zeroes following non-zero digits are significant.
- 4. If a decimal point is not expressed, zeroes following the last non-zero digit are not significant, they are place holders only.
- Zeroes preceding the first non-zero digit are not significant; they are place holders only.

Examples

- 4003 has four sig figures.
- 30.00 has four sig figures.
- 160 has two sig figures.
- 0.00610 has three sig figures.

How many sig figures?

- 1. 500,000
- 2. 406.200
- 3. 0.000300
- 4. 33.972
- 5. 8.14
- 6. 0.00567