Accuracy and Precision

Precision and Accuracy

Accuracy is a means of describing how closely a measurement agrees with the accepted or actual value of the quality being measured.

The question "how accurate were you?" could be replaced by "how close were you?"

Percent error is a measure of accuracy. A low percent error is more accurate.

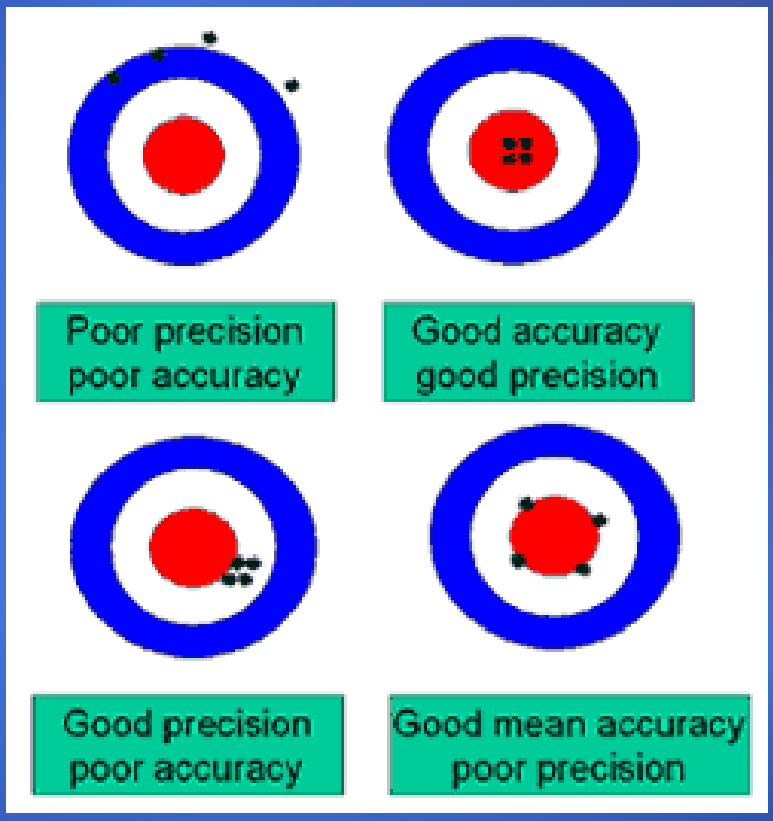
$$\% \text{ error} = \frac{\text{exp. value - theor. value}}{\text{theor. value}} \times 100\%$$

if I did an experiment to calc accel due to grav. I know I should get $9.81 m/s^2$, but I only got $8.0 m/s^2$:

$$\%\text{error} = \frac{(8.0 m/s^2 - 9.81 m/s^2)}{9.81 m/s^2} \times 100 = -18\%$$

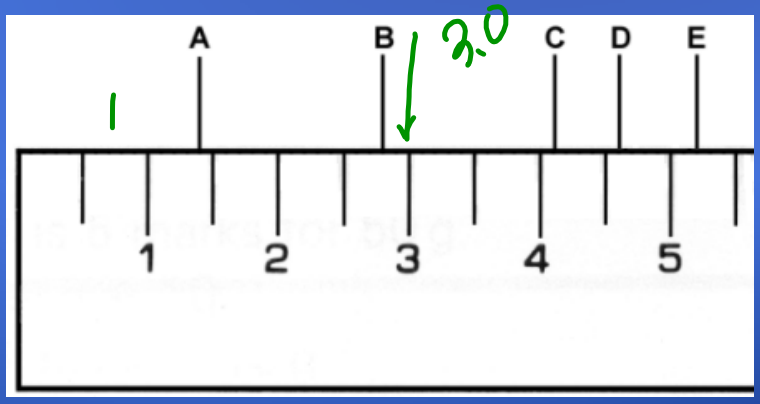
Precision is the degree of repeatability of measurements. Precision depends on technique and the tools used.

Accuracy vs Precision



The precision of an instrument depends on how finely the scale is divided.

Any measurement that falls between the smallest divisions on the measuring instrument is an estimate.



The accuracy of a measurement is indicated by the number of significant digits. Significant digits are used to communicate the degree of uncertainty in a measurement.

The number of significant digits is a response to the question: "How sure am I?"

Rules for identifying whether digits are significant:

1. Numbers obtained by counting and numbers obtained by definition are considered exact and have an infinite number of significant digits.

e.g. 3 students

1 m = 100 cm

2. All of the digits from 1-9 are significant

e.g. 1.34 cm 3 sig digs

198.3 kg 4 sig digs

3. All zeros to the left of the first non-zero digit are not significant.

e.g. 001.4 kg - 2 sig dig

0.00014 kg - 2 sig digs

4. Zeros between other non-zero digits are significant.

e.g 909.1 km , 4 sig digs

5. Any zero to the right of a non-zero digit is significant.*

e.g. 123.40 g - 5 sig digs

5000 m - 4 sig digs

5.000×10^3 - 4 sig digs for sure!

*Alberta Ed "Cheat"

Mathematical Operations with Data

Rule of thumb: you can't gain accuracy by conducting a mathematical operation, only by making new measurements.

Rules for adding and subtracting: the answer has the same number of decimal places as the value that has the least number of decimal places

e.g.

$$\begin{array}{r} 149.28\ \text{g} \\ +\ 1.094\ \text{g} \\ \hline 150.374\ \text{g} \end{array}$$

150.37 g

Rules for multiplying and dividing: the answer has the same number of sig. dig.'s as the value that has the least number of sig. dig.'s.

e.g. $(45.2\ \text{km})_{3} \times (11\ \text{km})_{2} = 497.2\ \text{km}^2$

$500\ \text{km}^2$

$5.0 \times 10^2\ \text{km}^2$

Unit Conversions

(i) Converting to base units

- convert 3.46 cm → m

  $3.46\ \cancel{cm}\ \times 10^{-2}\ m$

- 700nm → m

  $700\ \cancel{nm}\ \times 10^{-9}\ m$

(ii) Factor-Tag method

- 1462 g → ? kg

$$(1462\ g)\left(\frac{1\ kg}{1000\ g}\right) = 1.462\ kg$$

- 50 years → ? s

$$(50\ \cancel{y})\left(\frac{365\ \cancel{d}}{1\ \cancel{y}}\right)\left(\frac{24\ \cancel{h}}{1\ \cancel{d}}\right)\left(\frac{60\ \cancel{m}}{1\ \cancel{h}}\right)\left(\frac{60\ s}{1\ \cancel{m}}\right)$$

$$= 1{,}576{,}800{,}000$$

$$= 1.6 \times 10^{9}\ s$$

- 110 km/h → ? m/s

$$\left(\frac{110\ \cancel{km}}{1\ \cancel{h}}\right)\left(\frac{1000\ m}{1\ \cancel{km}}\right)\left(\frac{1\ \cancel{h}}{3600\ s}\right) = 30.6\ m/s$$

P1 #1-5
P2 #1-5
P3 #1-4, 9, 11-13