

Uncertainty is a numeric measure of confidence in a measurement or result. Measurements and Uncertainties

No measurement is ever perfectly exact or perfectly correct. Every measurement has a degree of uncertainty associated with it

1. If possible, record as many significant figures as the calibration of the measuring instrument allows **plus** one estimated digit.
2. Record a reasonable **uncertainty estimate with one sig fig** that matches the measurement in place value (decimal place).

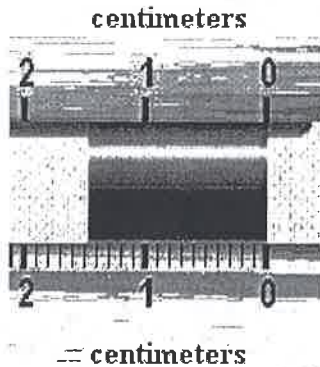
Record a measurement for the length of the steel pellet as measured by each ruler.

Top ruler:

$$1.4 \text{ cm} \pm 0.1 \text{ cm}$$

Range of values:

$$1.3 \text{ cm to } 1.5 \text{ cm}$$



Bottom ruler:

$$1.48 \text{ cm} \pm 0.02 \text{ cm}$$

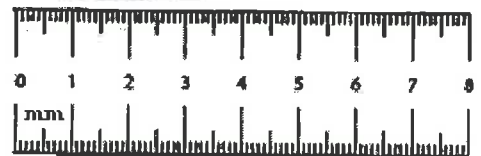
Range of values:

$$1.46 \text{ cm to } 1.50 \text{ cm}$$

What if the object doesn't have a sharp edge to measure from?

limit your precision to the first estimated digit

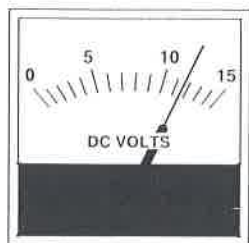
Measurement: $4.4 \text{ cm} \pm 0.2 \text{ cm}$



Record each measurement with an appropriate uncertainty:

1. Analog readings:

best judgment



$$11.6 \text{ V} \pm 0.2 \text{ V}$$



$$4.5 \text{ kg} \pm 0.2 \text{ kg}$$

2. Digital readings:
 \pm the smallest place value



$$115.2 \text{ g} \pm 0.1 \text{ g}$$

3. Stopwatch:

$$24.25 \text{ s} \pm 0.25 \text{ s}$$



$$24.3 \text{ s} \pm 0.2 \text{ s}$$

Single Trials and Multiple Trials

Task: Drop a ball from 1m + catch it.

Your measurement:

Class measurements:

0.53s 0.62s 0.48s
 0.58s 0.37s
 0.40s 0.75s

class average = 0.53s

1. What are some reasons for the variations in answers?

- reaction time
- hearing
- type of ball
- procedural error
- different place to catch ball
- tools / instruments

- sight

parallax - uncertainty in measurement due to perspective of person reading the instrument

2. Reporting a measurement using **a single trial**: Your value: 0.6s ± 0.2s

Value: your best measurement / **raw value**

Uncertainty: reasonable estimate

Rules for uncertainties:

- a) has only one sig fig
- b) matches the measurement in precision or place value

3. Reporting a measurement using **multiple trials**: Class value: ~~0.5s~~ ± 0.2s

Value: **average** measurement 0.5s ± 0.2s

Range: highest to lowest 0.75s - 0.37s

Uncertainty: ± 1/2 range $\frac{1}{2} (0.75s - 0.37s) = 0.19s$
 0.2s