

Unit 2.1

Next 3 Units (particularly 3 & 4) will be **Kinematics**

- study and description of how objects move

Really only 2 quantities we can measure:

- | | | |
|------------------------|---|------------------------|
| 1) location (position) | ⇒ | • Direct measurement |
| 2) time | | • Relative measurement |

Rest (most) of the other kinematic quantities need to be calculated from position and time

- i.e. speed → indirect measurement

To find speed \Rightarrow 1. Define speed in terms of position & time

$$\langle v \rangle \equiv \frac{x_2 - x_1}{t_2 - t_1}$$

2. Measure the 2 positions and corresponding times
3. Calculate the speed

However, all the measurements will have an uncertainty to them.

\Rightarrow Different than error

Errors are avoidable and should be corrected.

Uncertainty is inherent and always present.

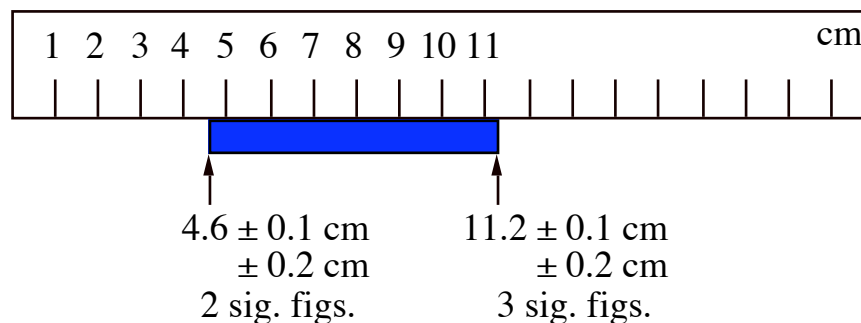
When discussing sources of uncertainties in your data, human error is **not** a valid source.

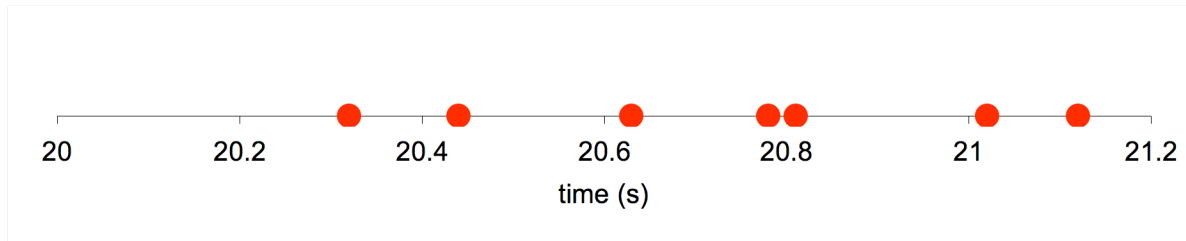
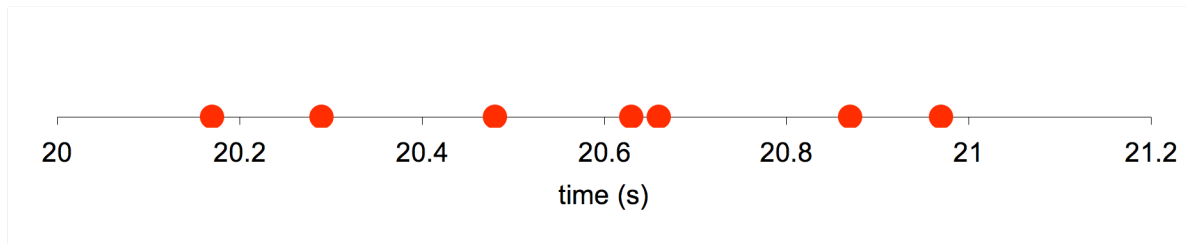
Unit 2.2

Appendix C (A-22 – A-24) of AG has information on significant figures, as does section 1-4 in Giancoli.

From here on, all measured numbers you record must include an uncertainty with them, with the correct # s.f.'s

- best estimate (single measurement)
- standard deviation, σ_{sd} (multiple measurement)
- standard deviation of the mean, SDM (multiple measurement)
- uncertainty propagation (indirect measurements)





	<i>t</i> (s)
1	20.63
2	20.17
3	20.29
4	20.87
5	20.66
6	20.48
7	20.97

	<i>t</i> (s)
1	20.78
2	20.32
3	20.44
4	21.02
5	20.81
6	20.63
7	21.12

Average = 20.5814286

Average = 20.7314286

Unit 2.2 (cont.)

There are a number of factors that can limit the # of significant figures (**precision**) in your measurement.

- physical properties of the object or phenomena being measured
- limitations in the measuring device being used
- the technique employed

Unit 2.3

Contest for homework

- Rules for the contest given on page 16 of the Activity Guide
- Stopwatches, meter sticks, etc. must be checked out through me.

Unit 2.4

- Errors:
- Human errors/mistakes, i.e reading numbers wrong.
 - Systematic errors, i.e. meter stick made too short.

Should look for and eliminate errors.

- Uncertainties:
- Impossible to measure exact value of a quantity
 - Always present
 - Inherent in measuring device
 - Random variations

Unit 2.5

To increase our chances of having a measured value close to the actual, true value (**accuracy**):

⇒ Take repeated measurements of the quantity, and then take the average

t (s)

0.31

0.37

0.38

0.36

0.32

0.34

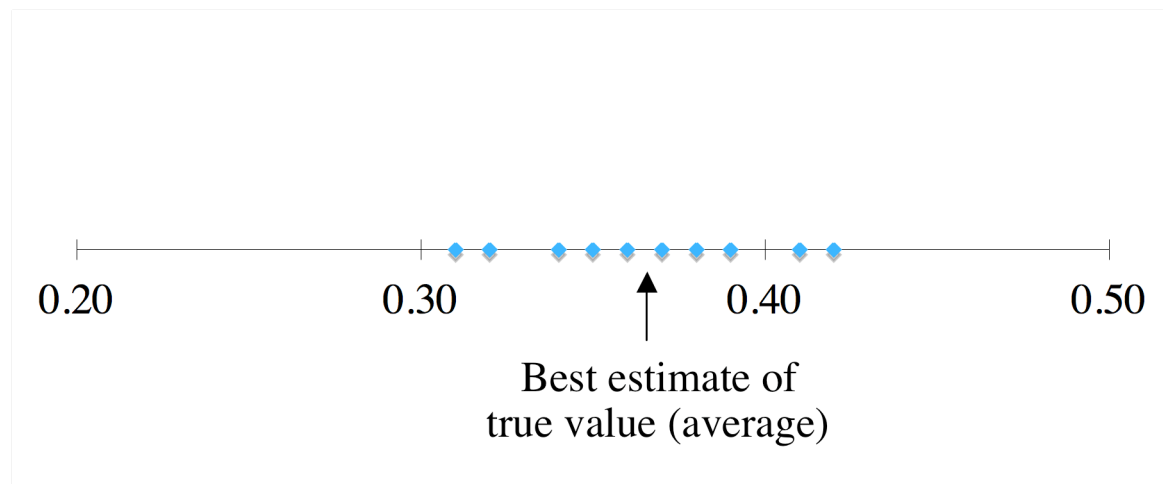
0.39

0.42

0.41

0.35

Average = 0.37



Everyone times 20 drops of the ball.

Unit 2.6

Now that we have multiple measurements of our quantity

- ⇒ find the standard deviation
 - uncertainty (**precision**)

Use the symbol σ_{sd} (Greek letter, lower case **sigma**)

In Excel, use the formula STDEV(...)