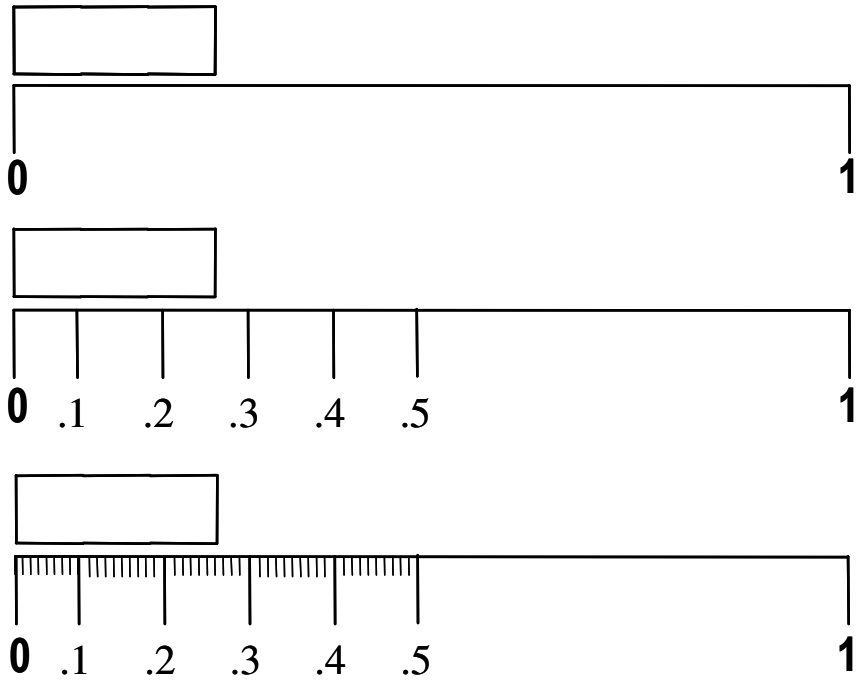
One Page Lesson: Where do "Significant Figures" come from?

Whenever you make a measurement and record its value and unit, the number that you write down should *always* express the *uncertainty* in that measurement. Another way to say this is: *you should always record the measurement with the appropriate number of "significant figures."*

The significant figures in any measurement are ***those digits that are known with certainty to be accurate, plus one additional digit whose accuracy is uncertain.*** *Every* measurement will *always* contain some uncertainty due to the limitations of the measuring device and/or the skills of the observer.

In the case of a ruler, this uncertainty comes from *estimating one decimal place past the smallest increment that is marked.* To see this illustrated, take a look at the metric ruler below, which we'll pretend is one meter long. A one meter ruler is commonly known as a "meter stick."



In the first drawing, the smallest increment on the meter stick is one meter. You're to use this meter stick to measure the length of the box that is directly above it. Clearly the length of the box is much closer to 0 than it is to 1 meter. So you could estimate between the 0 and 1 marks on the meter stick, and record your measurement as 0.2 or 0.3 m. *This single digit contains uncertainty because you had to estimate it.* Thus your measurement using this ruler contains just *one* significant figure.

The second meter stick is marked in increments of $1/10^{th}$ of a meter, or 0.1 m. Now when you measure the box, you can estimate between these marks, and record your measurement to $1/100^{th}$ of a meter, or 0.01 m. This time you know *with certainty* that the box is between 0.2 and 0.3 meters long. And you can estimate between those marks to record the length of the box as perhaps 0.26 or 0.27 meter. Again, *that last digit contains some uncertainty because you had to estimate it.* So your measurement using this ruler contains *two* significant figures.

Finally, the smallest increment on the last meter stick is $1/100^{th}$ of a meter, or 0.01 m. You can now estimate the length of the box to the nearest $1/1000^{th}$ of a meter, or 0.001 m. You can say *with certainty* that the box is between 0.27 and 0.28 meters in length. And you can then determine the last significant digit by estimating between those marks. This time, because the marks are so close together, you would be wise to estimate the last digit as either a half or a whole: 0.000 or 0.005 m. Thus you would record the length as either 0.270 or 0.275 meter. The measurement made using this ruler contains *three* significant figures.

Whenever you make your own measurements, you'll always have an awareness of the uncertainty they contain. But at other times, you'll be provided with measured values and asked to use them in calculations. So you must also be able to look at a provided measurement and assess the number of significant figures that it contains. This is an extremely important skill, because you should *never* make the mistake of indicating that your *calculated result* has *greater* certainty (or *less* certainty) than the measurements that you used in its calculation. And if you report a calculated result with *more* digits (or *fewer* digits) than you are entitled to, that is precisely the mistake you'd be making.

For help with assessing the significant figures in a provided measurement, or using significant figures in calculations, please see the One Page Lessons on those topics.

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