
ME 120 Experimental Methods

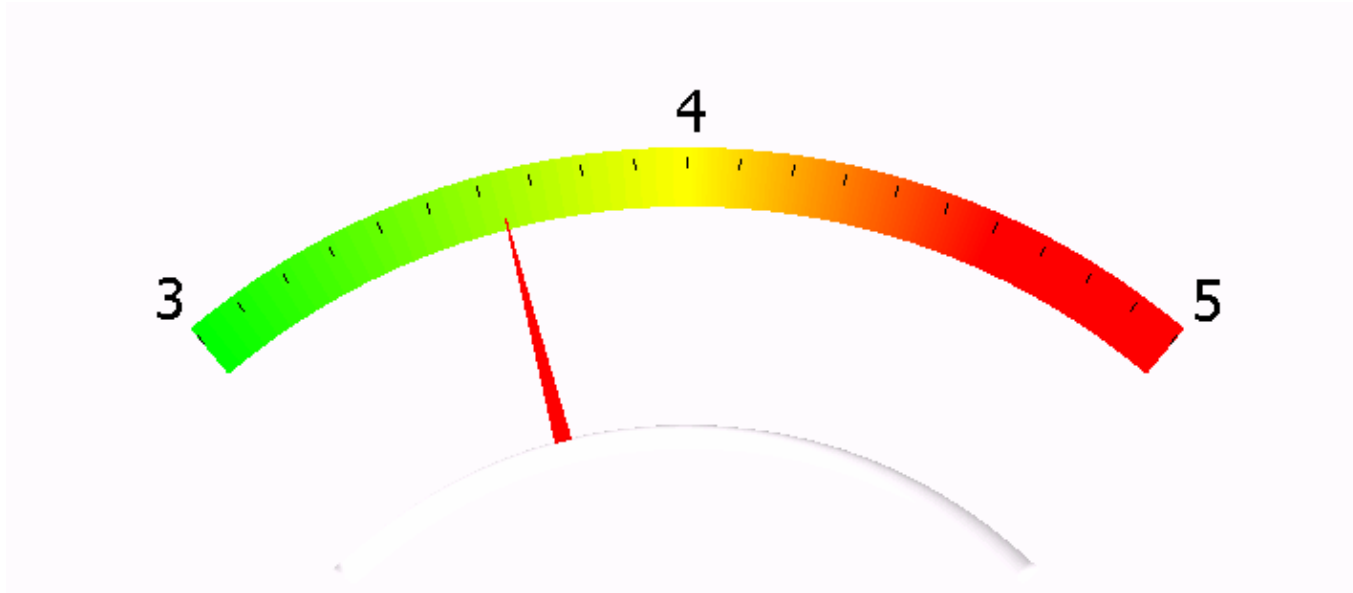
Significant Figures and Rounding

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Significant Figures

- ◆ A “significant figure” in a measured value is one that is known with certainty or can be reasonably estimated.



How would you report the meter reading? How many significant figures does your answer have?

Significant Figures

- ◆ When measured quantities are reported, the last significant digit in a measurement is somewhat uncertain. (Park, 1996)
 - ❖ "...the last significant digit is a carefully considered estimate by the experimenter and represents the limit of his or her ability to measure, given the measuring instrument being used and the conditions under which the measurement is made. This uncertainty carries over into the result calculated from the measurements. Thus the number of significant figures in a quantity is the number of trustworthy figures in it, the last trustworthy figure being somewhat in doubt (but still useful), because it is based upon an estimation." (Park, 1996)

Significant Figure Rules

- ◆ (Park, 1996) gives three basic rules for determining how many significant figures are in a number:
 1. ***Non-zero digits are always significant.***
523.7 has ____ significant figures
 2. ***Any zeros between two significant digits are significant.***
23.07 has ____ significant figures
 3. ***A final zero or trailing zeros in the decimal portion ONLY are significant.***
3.200 has ____ significant figures
200 has ____ significant figures
 2.00×10^2 has ____ significant figures

Practice

Number	Sig. Figs	Rule No.
0.0050		
0.03040		
2.30×10^{-5}		
96,000		
7801.0		

Exact Numbers

- ◆ Exact numbers can be thought of as having an infinite number of significant figures:
 1. 12 items in a dozen
 2. 12 inches in a foot
 3. 60 seconds in a minute

"Rules" on Rounding (read, "guidelines" on rounding)

- ◆ Example: 3.141592653589 (What number is this?)*
- ◆ Look at the number to the immediate right of the place you are rounding to:
 - ❖ If it is greater than 5 (i.e., 6, 7, 8, or 9), round the place of interest up.
 - So π to 4 decimal places is _____
 - ❖ If it is less than 5 (i.e., 0, 1, 2, 3, 4), leave the place of interest unchanged.
 - So π to 2 decimal places is _____
 - ❖ If it is 5 (use the round-to-even rule):
 - round **up** by one if there are any non-zero digits following the 5
 - If there are only zeros following the 5,
 - round **up** by one if the place of interest is *odd*, or else leave it unchanged if it is even.
 - So π to 3 decimal places is _____
 - So π to 7 decimal places is _____

Significant Figures in Calculations

◆ Multiplication and division (standard rule):

- ❖ Round the result of the operation so that it has the same number of significant figures as the least precise number used in the calculation.

- Ex. $2.0 \times 3.550 \times 10^{-6} =$ _____

- ❖ Alternate rule: add one more sig fig to result

◆ Addition and subtraction:

- ❖ Round the result of the operation so that its decimal portion has the same number decimal places as the decimal portion of the least precise number used.

- Ex. $3.1205 - 0.11 =$ _____

References

- ◆ Beckwith, T. G., Marangoni, R. D., Lienhard, J. H., *Mechanical Measurements*, Addison-Wesley, Reading, MA, 1995.
- ◆ Hestand, M. B., Alciatore, D. G., *Introduction to Mechatronics and Measurement Systems 2nd ed.*, WCB/McGraw-Hill, Boston, 2003.
- ◆ Park, J. L., Rules for Rounding Off [Online]. Available at <http://dbhs.wvusd.k12.ca.us/webdocs/SigFigs/SigFigs.html>, 1996.
- ◆ Rounding (from Wikipedia) [Online]. Available at <http://en.wikipedia.org/wiki/Rounding>
- ◆ NIST Guide to SI Units – Appendix B [Online]. Available at <http://physics.nist.gov/Pubs/SP811/appenB.html#B.7>
- ◆ * “See, I have a rhyme assisting my little brain its tasks sometime resisting” (the number of letters in each word gives pi to 12 decimal places)