Uncertainty in Measurements

Types of error:	How big is an error?	Describing the results:
Random	Absolute Error	Accuracy
Systematic	Relative Error	Precision

When you measure the desk with a yardstick and tell you that you found the length was 28.1250 inches, I am very skeptical. Your report indicates that you have confidence in the result to the ten-thousandth of an inch, and I don't believe you could really have that level of confidence from measuring with a yardstick. Your measurement is given **very precisely**. It may or may not be very **accurate**.

Another colleague measures the desk again with a tape measure. He measures that it is 28 1/16 inches long. He also looks at the order form for the desk and found that the manufacturer said that the desk is 28 inches long. Assuming the manufacturer is correct, how accurate is your colleague's measurement?
Answer: The **absolute error** in his measurement is 28 1/16 – 28 inches = 1/16 inch
The **relative error** in his measurement is (28 1/16 – 28) / 28 = (1/16)/28 = 0.0022 or 0.22%

When your colleague measured with that tape measure, he might have made a bit of error in placing the end of it exactly at the edge of the desk. Or he might have an error because this is an old tape measure and it's been used so much that it has stretched out and isn't giving accurate measurements. When the possible error is from exactly where you place the beginning, that is probably **random error**, since it could be on either side of correct and is randomly different each time. When you use a stretched tape measure, that is **systematic error** because the errors are always in the same direction. (Which direction? If the tape measure is stretched, and the desk is actually 28 inches long, what will the stretched tape measure tell you the length is – more than 28 inches or less than 28 inches?)

Activity 1. With these ideas in mind, do these exercises: 35, 45, 49, 56

Activity 2:
Correctly communicating your confidence in your measurement. Significant digits.
Read the first two and a half pages of the chapter and work through these examples.

Using the rules for significant digits to **combine (add, subtract, multiply, or divide) measured numbers**.
Read the end of page 168 and all of page 169. Work through these examples.

Activity 3: Now work all ten of the Quick Quiz problems at the end of the section.

Section 3E. How Numbers Deceive: Polygraphs, mammograms, and more.

There are three main topics in this section (Simpson's paradox, medical tests, and political math.) Ideally we can talk about each of these on different days. This will work better if you read them before class.

page 183. Discuss which of the acne treatments is better. Does it depend on the type of acne you have?

What is the "paradox" here? (Paradox means something that is true, but it seems that it couldn't be true.)

What is the "imbalance" that is causing this paradox?

HW and Quiz 7:

3B: 9, 15, 17, 19, 23, 25, 27, 31, 35, 37, 41, 45, 47, 53 (only Mercury and Neptune), 55, 59, 63
3E: 11, 13
3C: 2-6, 15, 17, 19, 23, 29, 31, 37, 41, 47, 53, 55, 57, 65, 75 (You might find a spreadsheet helpful on 75. The second answer in the back is incorrect in some books.)
Quiz: 3B: 32 and either 79 or 80
3E: 12
3C: 14, 32, 48, 58