Metric system of measurement

I brought a meter stick to class yesterday. You all saw that it's a little more than a yard long.

Why do many people say the metric system is a lot easier to use than the English system? (Answer: All conversion factors are powers of ten)

How many yards in a mile? versus How many meters in a kilometer?

How many feet in a mile? versus How many centimeters in a kilometer?

Prefixes:
There's some memorization here – you need to know the prefixes. In particular, you need to know those that are underlined on p. 112, because those are commonly used in labs. Which of those did you not know before you came in here today? (My answer: I was a little vague on nano and pico. And sometimes I get the symbols for milli and micro mixed up when I write them. Do you see why?)

So, what sorts of problems do we do here?
Read the problem on p. 111 at the end of the second column. Do you see why someone would care about that? That's a rather long word problem. Can you sort out the mathematical question they are asking there? Read it again. Try to put the question into a sentence. Talk to your neighbor about it.
(Answer: Is 100 pg more or less than "a few micrograms"?)

How would you answer that question?
Is it obvious that you need to get these two quantities converted to the same units so that you can compare them?
There are lots of choices of what units to use. Let's just convert them both to grams. Do that.

100 pg. Since 1 pg is 10^(-12) grams, then we have 100*10^(-12) , which is 1*10^2 * 10^(-12) = 1^ 10^(-10) grams.

A few micrograms: 1 microgram is 1*10^(-6) grams. So a few micrograms might be about 3* 10^(-6) grams.

So, how does 1*10^(-10) compare to 3*10^(-6)? Answer: 100 pg is much smaller than even 1 microgram.

So what does that mean about the patient who is given 100 pg of botulism?
Answer: He lives, and can open his eyes.

More about vocabulary and how to think about all of this.
(Which is not really the mathematics, but is about communication.)

1. It is a lot more important to learn to think in metric units than to do accurate conversions from English to metric units. Dr. Fletcher tells me that you'll get very used to how much 100 ccs is, because you'll measure that out in the lab a lot. She finds that she is "bilingual" in English and metric units. In the lab she thinks in metric units, and when she goes home and cooks, she measures in cups and tablespoons, because that's how the recipes are written.

2. When you do think about conversions, think about approximations, such as that a kilogram is a little more than 2 pounds, or a liter is a little more than a quart, or a meter is a little more than a yard.

3. Make sure that you understand the basic metric units and what they measure:
   a. Meters: length
   b. Grams: mass (weight)
   c. Liters: volume
   d. For more, see page 114, Table 8.4. I'm told that, in introductory material in biotechnology labs, you can focus on length and mass, so meters and grams. When you need others in this course, someone will tell you.

4. There are some metric units that fall outside of the regular metric system. See p. 112, the second column, the middle paragraph, starting with "There are a few terms …" I suggest that you make a note of these in your notes for this class.

5. If you need to convert between English and metric units, find the conversion factors on p. 114, Table 8.3.

Let's do a couple of problems.
p. 114, problem 2
p. 114, problem 3

For problem 3, let's first approximate. A liter is a bit more than a quart. A soda can is 12 oz, which is 1.5 cups. There are 4 cups in a quart. So 1.5 cups is a bit more than 1/3 of a quart. Since a quart is somewhat less than 1 liter, then we would guess that a soda can holds about a third of a liter.

Now, do the calculation for problem 3. Does your answer come out to be close to what you approximated?

If there's time left, we'll talk about ways of measuring temperature.

Discuss why Celsius is not in the SI system, even though it is based on 100, which is a power of ten.
Basic answer: The zero is not a "natural" zero. It is an arbitrary zero – the freezing point of water, but that's about water, not about temperature. It is kelvins in which the zero is

an absolute zero. (For discussion of absolute zero, see http://www.sciencetheatre.org/ask_st/012992.html) So kelvins are the SI measurement unit for temperature. But, in labs, we typically use Celsius. The degrees in Celsius are the same size as kelvins – but the zero is different.

More language: Temperature Celsius is also called temperature centigrade. Strictly speaking, they were originally slightly different. But, as science advanced, they were defined more precisely, and so redefined to be the same. This is pretty interesting history. http://www.sizes.com/units/temperature_centigrade.htm or http://en.wikipedia.org/wiki/Centigrade

In kelvins, the size of a unit is the same size as a degree in temperature Celsius. Much lesser known is degrees Rankin, in which the zero is also absolute zero and the size of a degree is the same size as in temperature Fahrenheit.

Why does this business of absolute zero important?
Basically, it is because we like for different measurement scales to have a proportional relationship. In order for that to be true, we need for the zero in both systems to be measuring the same physical quantity. So kelvins and degrees Rankin are proportional. Degrees Celsius and degrees Fahrenheit are not proportional.

If absolute zero is important, why don't we use scales that have it?
Answer: It is inconvenient to use measurement scales where the zero is the measure for something that we don't normally experience. Since we don't normally experience absolute zero temperatures, and, in fact, they are far below anything we normally experience, practicality made people choose a measurement scale for temperature where zero was a value that they understood.