Dr. Baxley’s tips for Dimensional analysis problems:

Here is a problem to work on, and I will give tips on how to go about solving the problem as you read along.

The speed of a train is measured to be 45 miles per hour. What is the speed in cm/ms (centimeters per millisecond)? Helpful info: 1 mile = 5280 feet (exact).

**Analyze**
1. Start by determining what the question is asking.
2. Collect the information given or available in the problem. Write conversion formulas as ratios.
3. Look for a measured value, circle it.

**Plan**
4. Make a plan for how to solve the problem. See where you can go from the beginning of a problem, and maybe how you could work backwards and meet in the middle.
5. Think of the goal as being how to understand the relationship between one set of units and another. If cookies come in a package of 2 dozen, and there are 12/dozen, you can use these relationships to find how many cookies are present.
6. Determine what ratios or conversion factors you might need that are not included in the problem.
7. Conversions or ratios can be used as given in the problem/text, or can be inverted.

\[
\text{The ratio } \frac{12 \text{ in}}{1 \text{ ft}} \text{ works just as well as } \frac{1 \text{ ft}}{12 \text{ in}}
\]

**Solve**
8. Start by writing the measured value. Multiply with the ratios according to your plan, using them properly to make sure units cancel. Write out all units.
9. You can put a long string of conversions together, or do them separately. I will show them together most of the time.

**Check.**
10. Look at the magnitude of your conversions and measured values. Does your final answer make sense? Do all units cancel out to the target units?

OK, Let’s solve the problem above, following the steps outlined here.

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1. The problem is asking “what is the speed in cm/ms?” These should be the final units.
2. The problem gives us 1 mile = 5280 ft as a conversion factor.
3. The problem gives us a measured value of 45 miles per hour or 45 mi/hr.
4. Plan:
   a. Convert hours to seconds, via minutes. Then seconds to ms.
   b. Convert miles to cm. First, miles to feet. Then feet to cm.
5. These relationships are not too bad, as long as one looks for small changes (miles to feet) and not big leaps (miles to cm)
6. To get hours to minutes, need \( \frac{60 \text{ min}}{1 \text{ hr}} \) and \( \frac{60 \text{ s}}{1 \text{ min}} \)
   To get s to ms, need \( \frac{1000 \text{ ms}}{1 \text{ s}} \)
   To get miles to feet, use \( \frac{5280 \text{ ft}}{1 \text{ mi}} \)
   To get feet to cm, need feet to inches first, then inches to cm \( \frac{12 \text{ in}}{1 \text{ ft}} \) and \( \frac{2.54 \text{ cm}}{1 \text{ in}} \)
8. Solve (start with measured value):

\[
\frac{45 \text{ mi}}{1 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} \times \frac{1 \text{ s}}{1000 \text{ ms}} \times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 2.01 \text{ cm/ms}
\]

Check: Changing the measurement from miles to cm would make the value for the train’s speed bigger (you’re multiplying the speed by a lot of big numbers). Changing the measurement from hours to ms would make the speed a smaller value. Seems OK!

Notes: Make sure units cancel. Use ratios appropriately, don’t be afraid to invert them. Sometimes you might work forward, others backward, sometimes both.

Piece of cake, right?

For more guidance, and practice, check out: http://www.chemistrycoach.com/use.htm