Lecture Problems
Chapter 1, sec 7

S.E. Van Bramer (9/12/97)

Problem Solving. While driving across South Dakota, I looked down at the odometer in my truck and started a stop watch at the same time. The odometer read: 129356.4. Some time latter I stooped the watch and looked at the odometer again. The odometer read: 129469.3 and the stopwatch read 94 min, 15.24 sec. What was my speed in miles per hour, kilometers per hour and meters per second?

To find velocity we need distance (from the odometer) and time (from the stopwatch). First the distance.

$$\text{start} := 129356.4 \cdot \text{mi}$$

$$\text{stop} := 129469.3 \cdot \text{mi}$$

$$\text{distance} := \text{stop} - \text{start}$$

$$\text{distance} = 112.90000 \circ \text{mi}$$

Look at the start and stop readings to determine how many significant digits the answer should have at this point. The start is in tenths and the stop is in tenths. The distance should be the LEAST precise of the two (rule for addition and subtraction). They are the same, so this is easy. The value should be in tenth's at this point. The following digit (0 in the hundredth's place) is less than 5, so round the 9 to 9.

$$\text{distance} = 112.9 \circ \text{mi}$$

Now calculate the time:

$$\text{time} := 94 \cdot \text{min} \cdot \left(\frac{60 \cdot \text{sec}}{1 \cdot \text{min}} \right) + 15.24 \cdot \text{sec}$$

$$\text{time} = 5655.24000 \bullet \text{sec}$$

But how do we figure the significant figures? Answer this question by thinking about where the uncertainty is in the measurement. Remember, this is what significant figures represent. Is the uncertainty in the 94 min? Is it in the 15 sec? Or is it the two tenth's of a second? Or is it the 4 hundredth's of a second? So this answer is:

$$\text{time} = 5655.24 \cdot \text{sec}$$

To calculate miles per hour, the time must be converted into hours.

$$\text{time} \cdot \left(\frac{60 \cdot \text{sec}}{\text{min}} \right) \cdot \left(\frac{60 \cdot \text{min}}{\text{hr}} \right) = 1.57090000 \circ \text{hr}$$

Since the conversion factors are "exact" numbers, the solution should have the same number of significant figures as the time in seconds (the rule for multiplication and division). So this is written as:

$$\text{time} = 1.57090 \circ \text{hr}$$

$$\text{velocity} := \frac{\text{distance}}{\text{time}} \quad \text{or} \quad \frac{112.9 \cdot \text{mi}}{1.57090 \cdot \text{hr}} = 71.86962888 \circ \frac{\text{mi}}{\text{hr}}$$

From the rules for significant figures with multiplication and division. 112.9 has 4 significant digits, 1.56090 has six significant digits. 4 is the "least" number of significant digits, so the answer should have 4 significant digits. This means rounding to the 6 in the hundredth's place. Because the following digit is a 9, which is more than 5, the 6 rounds up to a 7. The answer is written as:

$$71.87 \cdot \frac{\text{mi}}{\text{hr}}$$