PSC 1121 Celebration of Knowledge 1 Fall 2002

Problem 1. (15 points)

To help his teammates finish up an activity after class, Jorge agrees to find the mass (in grams) of the last four objects himself. The fours sets of measurements are shown below.

a. Known value: 32.0
Measured values: 29.7, 33.9, 32.1, 32.3

b. Known value: 9.8
Measured values: 9.8, 7.2, 13.8, 8.4

c. Known value: 158
Measured values: 102, 176, 201, 84

d. Known value: 0.43
Measured values: 0.20, 0.21, 0.20, 0.19

A. For each set, indicate if the measurements are accurate, precise, both or neither and explain why.

a.) These measurements are both accurate and precise. The average of all 4 measurements is 32.0 which is the same as the known value, which makes the measurements accurate. The measurements are also precise because they are all pretty close.

c.) These measurements are neither accurate nor precise. The average of all 4 measurements is 140.75 which is no where close to the know value of 158, making the measurements NOT accurate. They are also not precise b/c the msts are not close at all. They are very spread out.

b.) These measurements are accurate but not precise. The average of all 4 measurements is 9.8 which is equal to the known value (9.8), making the msts accurate. They are not precise b/c the msts are not close. They are very spread out.

d.) These measurements are not accurate, but are precise. The average of all 4 measurements is 0.20 which is no where near the known value of 0.43, make the msts NOT accurate. They are precise however b/c the msts are close together.

B. For each object, what mass measurement should Jorge report to his teammates and what is the uncertainty in his measurements?

For each object Jorge should report the average mass. So for example

A → 32.0 B → 9.8 C → 141 D → 0.20

To find the uncertainty of his measurements he needs to find the difference between the highest value and average, and between the lowest value and average for each object. Then take the larger number of the two and that will be Jorge's uncertainty for each object.

A. 33.9 - 32.0 = 1.9
32.0 - 29.7 = (2.3)

B. 13.8 - 9.8 = (4.0)
9.8 - 7.2 = 2.6

C. 201 - 141 = (60)
141 - 84 = 57

D. .21 - .20 = (.01) or either one
.20 - .19 = (.01)

Now the reason I chose to take the average number of the 4 measurements to find the uncertainty and not the known number is because that is what we were taught in class.

See comments on next page

Problem 1 (cont.)

Dr. Saul's comments on Problem 1: *The main difficulties I saw with this problem were the following:*

- *Confusing accuracy and precision*
- *Just using the difference between the largest number and the average rather than looking for the largest difference between a measurement and the average. (Alternatively, you could have used half the difference between the largest and smallest measurements as the uncertainty.)*
- *Significant digits – your answers should have the same precision as the numbers used to calculate them. Thus the average for the data set in part c is 141, not 140.75.*

The reason you use the average of your measurements and not the known value is that the uncertainty should be determined from your measurements, that is, it's a measure of how precise your measurements are. For example, if your uncertainty is approximately 1/3 of your average value or more, the measurements are not very precise. This is because the spread of values is almost equal to or more than the average value. And if the known value is not within your uncertainty of your average measured value, this is an indication that your measured average value is not accurate.