## Best Value and Uncertainty Exercises

Calculate the best value and the uncertainty for the problems below. Determine whether there are any outliers that should be discarded (remember not all outliers should be thrown out) before you find your best values. If you discard data, state the reason why.

1. Susan is trying to figure out her “weight.” She has a bathroom scale that is digital and goes to the tenths place. One morning she “weighs” herself 5 times. The values she records are: 120.0, 128.2, 125.5, [152.5] and 123.7 pounds. Determine the best value and uncertainty for Susan’s weight.

   \[ \text{Best value} = \frac{120 + 128.2 + 125.5 + 123.7}{4} = 124.35 \text{ pounds} \]

   \[ \text{Uncertainty} = 124.35 - 120 = 4.35 \text{ pounds} \]

   \[ \boxed{124.35 \pm 4.35 \text{ lbs}} \]

2. Sophie keeps track of her car's gas mileage. She divides the number of miles she drives by the number of gallons she puts in her car during each gas station fill-up. These are the values she calculates for her gas mileage after 10 fill-ups at the gas station: 25.3, 26.2, 24.1, 23.4, 27.5, 25.4, 15.2, 26.4, 22.1, 24.4 mi/gal. What is the best value and uncertainty for the gas mileage of Sophie’s car?

   \[ 25.3 + 26.2 + 24.1 + 23.4 + 27.5 + 25.4 + 15.2 + 26.4 + 22.1 + 24.4 \]

   \[ \text{Best value} = \frac{24.5}{10} = 2.4 \text{ mi/gal} \]

   \[ \text{Uncertainty} = 2.4 \text{ mi/gal} \pm 8 \text{ mi/gal} \]

3. John's growing a Chia Pet. He measures the amount of growth in millimeters that he sees each day in his pet. He gets these numbers for each of the following 20 days:

   Day: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
   Growth: 0 1 1 2 1 2 3 3 2 3 2 1 2 1 0 0 0 0 0

   What is the best value and uncertainty for the growth rate of John’s Chia pet?

   \[ \frac{3}{5} = 1.25 \text{ mm/day} \]

   \[ \text{Uncertainty} = 1.25 \pm 0.25 \]

4. Marlena sets up a science experiment where she is trying to determine the effects of tension and length on the pitch (frequency) of a guitar string. She does 5 tests. In each test she increases the force she applies to the string by 10 Newtons, and she increases the length by 10 cm. What is wrong with Marlena’s experimental set-up, and how can she fix it?

   In Marlena’s experiment, there are two independent variables: force and length. However, for a proper experimental set-up, there can only be one independent variable: either force or length.

5. Geoff needs to know the length of his spring when there is no mass on it. Laying it on the table, he measures it 6 times and records the following data: 23, 23.2, 22.4, 24.1, 23, and 23.25 cm. What is the best value and uncertainty for the length of Geoff's spring?

   \[ \text{Best value} = \frac{23 + 23.2 + 22.4 + 24.1 + 23}{5} = 23.2 \text{ cm} \]

   \[ \text{Uncertainty} = \sqrt{\frac{(23 - 23.2)^2 + (22.4 - 23.2)^2 + (24.1 - 23.2)^2 + (23 - 23.2)^2 + (23.25 - 23.2)^2}{5}} = \sqrt{0.9} \text{ cm} \]