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## Activity 2a: Length Measurements with the False Meter Stick

Equipment Required	Part Number
Meter stick label 80 cm/100 div	part of ME-9849
Number line	part of ME-9849
Data pointers	part of ME-9849
Sample object (for measuring)	
Vernier Caliper	

### Before the Lab:

1. Find an irregular object as in the picture.



### Procedure

1. Measure the length of the sample object with the meter stick label by taking the difference between the endpoints of the object on the "meter tape." (For now, you may use as many digits after the decimal point as you want.)
2. Write your measurements on a data table similar to the table below:

Trial	Initial Position (cm)	Final Position (cm)	Length (cm)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

3. Position the object somewhere else on the "meter tape." Measure the object's length.
4. Repeat step 3 until you have a total of 10 trials.

## Post-Lab Discussion

With the help of your teacher, use a vernier caliper to get an ACCEPTED value for the length of the sample. How does this value compare with your measured lengths using the "meter tape"? Discuss among your groupmates how the experiment demonstrate the fact that measurements that are not accurate can be precise as long as they are repeatable.

## Questions:

1. Were your results accurate? Explain.
2. Were your results precise? Explain.
3. Can the results be precise but not accurate? Explain.
4. Explain how the "meter tape" that was used in this activity influences the accuracy.
5. Explain how the "meter tape" that was used in this activity influences the precision.

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## Activity 2b: Length Measurements with the True Meter Stick

Equipment Required	Part Number
Four-sided meter stick	part of ME-9849
Sample object (for measuring)	

### Before the Lab:

1. Try to find an object of standard length that is easy to measure like the width of a sheet of paper.
2. Allow students to use as many significant figures as possible. (Do not discuss or use the term "significant figures.")
3. Write the following data table on the board.

Group #	Length (cm)
1	
2	
3	
4	
5	
6	
7	
8	

### Procedure

1. Measure the length of the object (in meters) with the meter stick. Use as many digits after the decimal point as you can read.
1. Write your measurement on the board.

### Post-Lab Discussion

The discussion should lead students to the conventional understanding of significant figures as the number of digits that can be read with certainty plus an estimated digit. This would be an appropriate time to discuss parallax with the students.

This would also be an appropriate time to discuss the role of zeroes in significant figures.

#### Place Holder Rule or Leading Zeroes

Zeroes that serve as placeholders are NOT significant.

Example: .003 g contains only one significant figure, the "3."

#### Right-Right Rule or Trailing Zeroes

Zeros to the right of the decimal AND to the right of the last significant figure are significant.

Example: 1.400 m contains four significant figures.

#### Decimal Rule (Used for Whole Numbers)

If a decimal is NOT included for a whole number, rightmost zeroes are NOT significant.

Example: 2300 km contains two significant figures.

If a decimal is included for a whole number, rightmost zeroes are significant.

Example: 2300. km contains four significant figures.

**Note:** Sometimes a line is written above a zero to identify that it is significant.

Example: 23 $\bar{0}$ 0 km contains three significant figures.

#### Sandwich Rule

Zeroes in between other significant figures are significant.

Example: 20.03 g contains four significant figures.

### Questions:

1. In this activity, a meter stick was used to make measurements. Make a list of techniques necessary to insure optimum precision when using a meter stick.

Sample values: .145 m    .144 m    .146 m    .144 m

2. How many digits can you read with certainty?
3. Which digit is uncertain?
4. For the following measurements underline the digits that are known with certainty and circle the digits that are estimated.

4.35 m    .009340 g    3400 km     $1.38 \times 10^3$  m/s