

Measurement

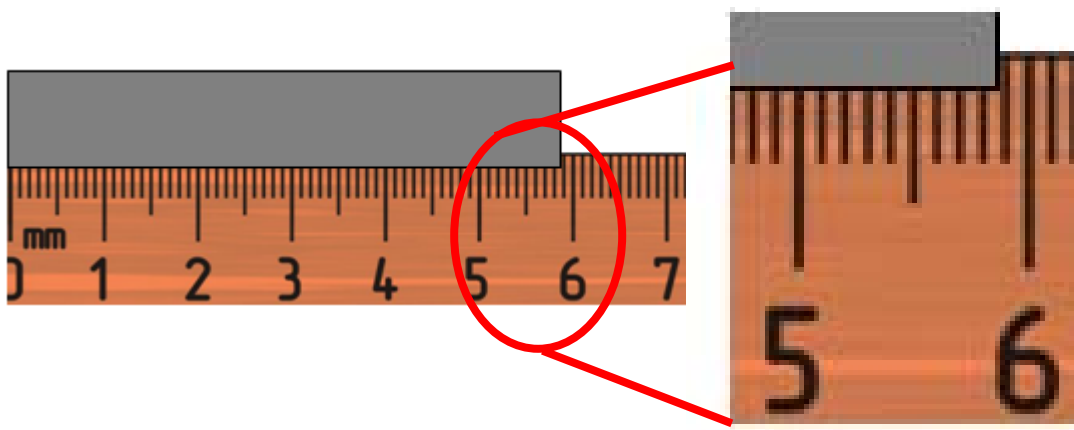
Name _____

Class _____

In this activity, you will explore the following:

- how to take and record measurements using different measuring devices
- significant digits and estimations of measurements

Science is built upon the ability to measure objects precisely. To create theories and laws in science we must have data, and data are acquired from repetitive measurements. This lab focuses on measuring precisely with a number of measuring devices. When taking a measurement, the last digit is an estimate. This estimate helps other scientists determine with what precision the measurement was made.



All measurements have an estimated value. The digit prior to the estimate is always a mark on the device. On the ruler above, the marks are every 0.1 cm, or 1 mm. All measurements are made by determining the marks on the measuring device (cm, mL, g, etc.) and then estimating one place beyond the precision of those marks. The object shown above is longer than 5.8 cm, but less than 5.9 cm. An appropriate reading for this would be 5.88 cm or 5.89 cm. The 5.8 cm is known, but the last digit is an estimate. In 5.89 cm, the 9 is the estimated value. Therefore, this measurement has three significant digits, two that are certain and one that is uncertain (an estimate).

Measurements have a certain number of significant figures or values that tell you about the measuring device. In the case of the measurement above, all of the digits are significant. The estimated value is significant because it helps define the precision of the device being used to measure.

Example:

- 12.0 L – There are three significant digits. The device is marked off every 1 liter. The 1 and 2 are certain, and the 0 is the uncertain or estimated digit.
- 0.00025 kg – There are two significant digits. The 5 is the uncertain value, the 2 is certain, and the device has marks every 0.0001 kg.
- 61,000 cm – There are two significant digits. The 1 is uncertain, the 6 is certain, and the device has marks every 10,000 cm.

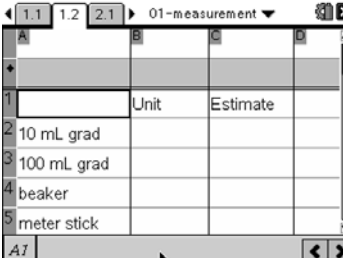
The following rules are used to help determine whether a value is significant or not:

1. All certain values and the estimated or uncertain value are significant.
 - 25.45 – Four significant figures
 - 25.4 are certain and 0.05 is estimated.
3. Zeros between nonzero values are significant.
 - 230.4 – Four significant figures
 - 230 are certain and 0.4 is estimated.
4. Trailing zeros (zeros to the right of the decimal) are significant only if a decimal point is present.
 - 23.000 – Five significant figures
 - 23.00 are all certain and the last zero is estimated.
 - But the number 23 has only two significant figures.
5. Leading zeros (zeros to the left of a nonzero) are not significant.
 - 0.0023 – Two significant figures
 - 2 is certain and 3 is estimated.

Problem 1 – Units of Measurement

Step 1: Open the file **01-Measurement.tns**. Observe the following measuring devices: 10 mL graduated cylinder, 100 mL graduated cylinder, meter stick, micrometer, and thermometer. Then, determine the smallest unit of measurement for each device as well as the estimated value for each device.

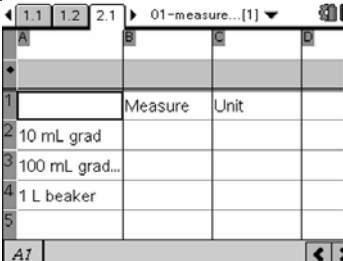
Step 2: Record the units and estimates in columns B and C on the *Lists & Spreadsheet* application on page 1.2. Be sure to add quotation marks (“ ”) around the entered values.



	A	B	C	D
1		Unit	Estimate	
2		10 mL grad		
3		100 mL grad		
4		beaker		
5		meter stick		

Problem 2 – Measuring Objects

Step 1: Move to page 2.1. Then, fill a 10 mL and 100 mL graduated cylinder and 1 L beaker $\frac{3}{4}$ full with colored water and measure the volume of the water. Record your measurements in the table on page 2.1. Include units in all of your measurements.



	A	B	C	D
1		Measure	Unit	
2		10 mL grad		
3		100 mL grad...		
4		1 L beaker		

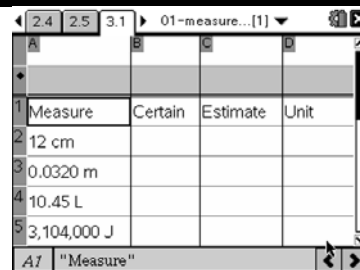
Step 2: Measure the volume of liquid in a 1 L beaker and record your measurements and units on page 2.1.

Step 3: Measure the length, width, and height of a wood block with both a ruler and a micrometer. Record your measurements and units on page 2.1. Then, answer questions 1–4.

- Q1.** The 10 mL graduated cylinder has marks every:
- 10 mL
 - 1 mL
 - 0.1 mL
 - 0.01 mL
- Q2.** The 100 mL graduated cylinder has marks every:
- 100 mL
 - 10 mL
 - 1 mL
 - 0.1 mL
- Q3.** The 1 L beaker has marks every:
- 100 mL
 - 10 mL
 - 1 mL
 - 0.1 mL
- Q4.** Which volume-measuring device has the greatest precision?
- 10 mL graduated cylinder
 - 100 mL graduated cylinder
 - 1000 mL beaker
 - They are all the same

Problem 3 – Analyzing Measurements

Step 1: Move to page 3.1. The spreadsheet on this page contains various measured values. Determine the certain digits, estimated digits, units of measurement, and number of significant figures for each measured value in the spreadsheet.



	A	B	C	D
1	Measure	Certain	Estimate	Unit
2	12 cm			
3	0.0320 m			
4	10.45 L			
5	3,104,000 J			

Step 2: Answer questions 5–8.

- Q5.** Determine the number that represents the mark on the device in the following measurement: 25.43 L.
- 20 L
 - 0.03 L
 - 0.4 L
 - 5 L
- Q6.** How many significant figures are there in 12.20?
- 1
 - 2
 - 3
 - 4
 - 5

Q7. How many significant figures are there in 0.025?

- 1
- 2
- 3
- 4
- 5

Q8. How many significant figures are there in 65,100?

- 1
- 2
- 3
- 4
- 5