• Examine the object being measured below:

• It appears to be between 3.2 cm and 3.3 cm long.
  o Perhaps it is 3.27 cm or 3.28 cm long.
  o The last number is estimated.
  o It makes no sense to say it is 3.275 cm long. Since the 7 is already estimated, the 5 is nonsense.
The measured length, 3.27 cm, consists of a measured portion and an estimated portion.

- There can never be more than one estimated digit in a measurement. It is always the last digit.

• Convert 3.27 cm to meters
  - 3.27 cm = 0.0327 m
  - There are still only two measured digits and one estimated digit. The zeros are placeholders.
The Nature of Significant Figures

• All measured and estimated values are significant figures.
  o 3.27 cm has 3 significant figures.
  o 0.0327 m has the same 3 significant figures. The zeros are place holders.

• Place holders are not significant figures.
  o All nonzero digits are significant.
  o Only zeros can be place holders.
  o Not all zeros are place holders, however. Some zeros are significant.
The significance of a zero depends on where it is compared to the nonzero digits and the decimal.

- **Decimal present**
  - All zeros to the right of the first nonzero digit are significant.
  - Leading zeros between the decimal and the first nonzero digit are not significant.

- **Decimal absent**
  - Trailing zeros, zeros following the nonzero digits, are not significant.
Atlantic Pacific Rule

Pacific
Decimal Present
Count toward the right from the first nonzero digit.

Atlantic
Decimal Absent
Count toward the left from the first nonzero digit.

0.0103
NOT Significant Significant

1,000
NO Expressed Decimal Significant NOT Significant
Consider the following problem, $2.17 \times 3.2$:

- The last digit of each number is estimated.
- Anything multiplied by an estimated value is also estimated.
- This results in an answer with 3 estimated digits. It must be rounded off to have only one.

- The resulting answer, $6.9$, has 2 significant figures like the smaller of the two multipliers.
Rules for Calculating with Significant Figures

• **Rules for Multiplication and Division**
  
  o The number of significant figures in a product or quotient is the same as the number of significant figures in the measurement with the smaller number of significant figures.

    o **Example**: $3.1415 \times 2.25 = 7.068375$
      
      *Correct number of Significant Figures* = 3
      
      *Solution*: 7.07

• **Rules for Addition and Subtraction**

  o The number of decimal places in the sum or difference is equal to the number of decimal places in the measured quantity with the smallest number of decimal places.

    o **Example**: $6.357 + 5.4 = 11.757$
      
      *Correct number of Decimal Places* = 1
      
      *Solution*: 11.8