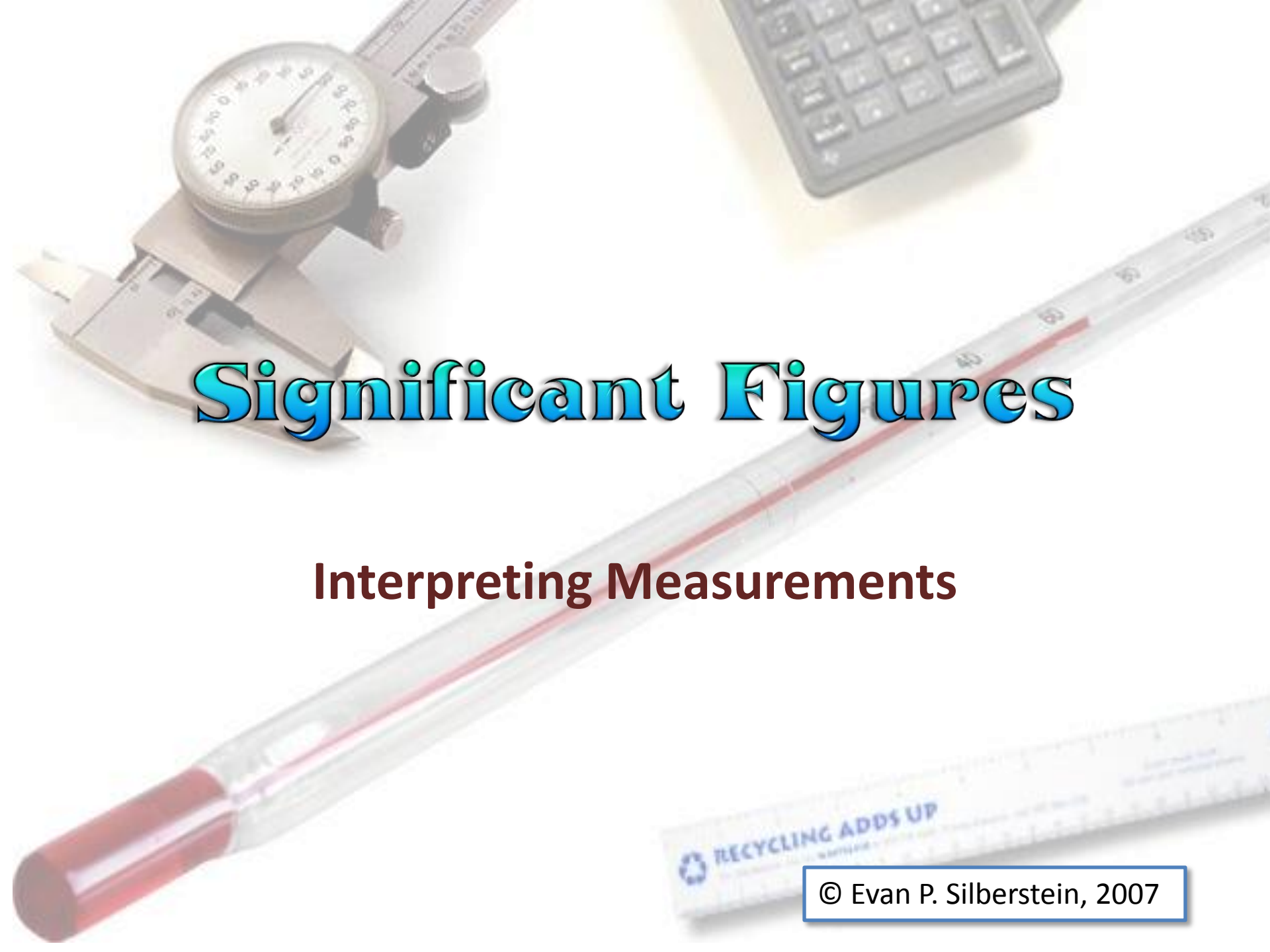
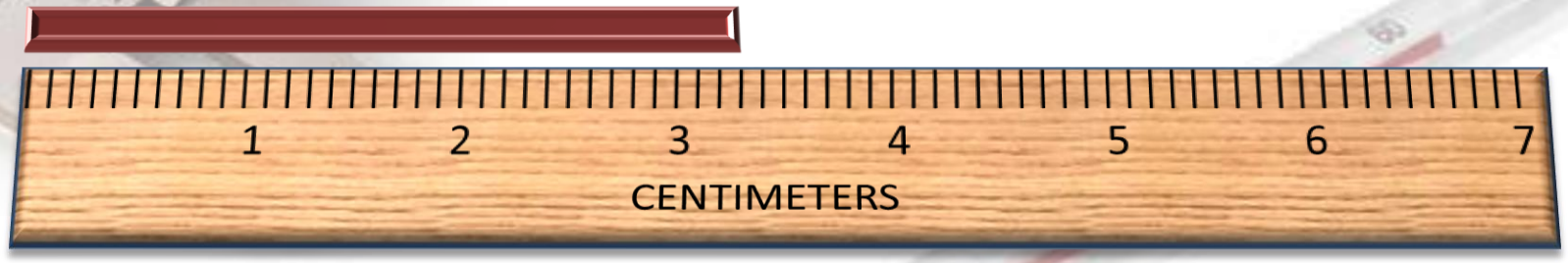


Significant Figures

Interpreting Measurements

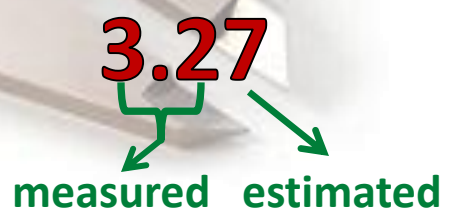
Estimation

- Examine the object being measured below:



- It appears to be between 3.2 cm and 3.3 cm long.
  - Perhaps it is 3.27 cm or 3.28 cm long.
  - The last number is estimated.
  - It makes no sense to say it is 3.275 cm long. Since the 7 is already estimated, the 5 is nonsense.

The Nature of Measurements

- 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.

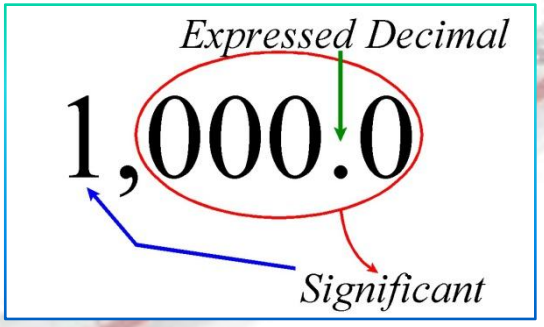
The Nature of Significant Figures

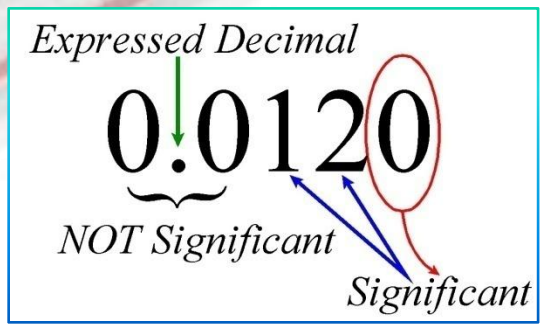
- All measured and estimated values are ***significant figures***.
  - **3.27 cm** has 3 significant figures.
  - **0.0327 m** has the same 3 significant figures. The zeros are place holders.
- Place holders are *not* significant figures.
  - All nonzero digits are significant.
  - Only zeros can be place holders.
  - *Not all* zeros are place holders, however. Some zeros are significant.

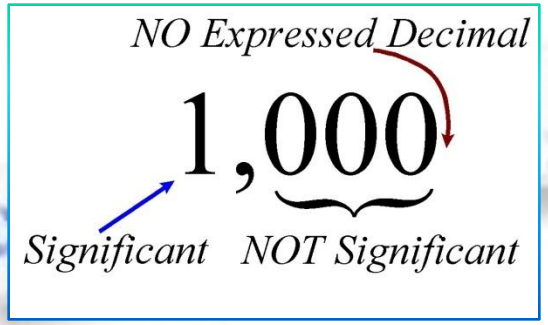
Identifying Place Holders

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 **P**resent

Count toward the right from the first nonzero digit.

Atlantic

Decimal **A**bsent

Count toward the left from the first nonzero digit.

Significant

0.0103

NOT Significant *Significant*

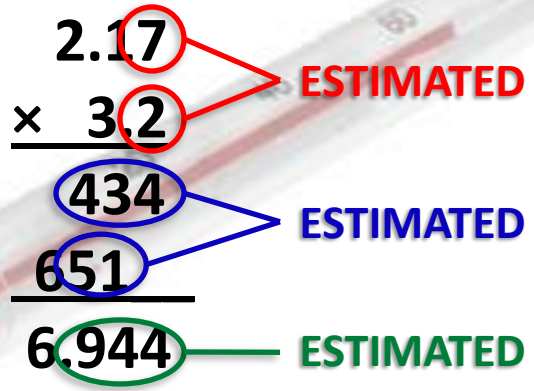
NO Expressed Decimal

1,000

Significant *NOT Significant*

Calculations with Significant Figures

- Consider the following problem, 2.17 × 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**
  - 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.
  - ***Example****:* 3.1415 × 2.25 = 7.068375
    Correct number of Significant Figures = 3
    Solution: 7.07
- **Rules for Addition and Subtraction**
  - 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.
  - ***Example****:* 6.357 + 5.4 = 11.757
    Correct number of Decimal Places = 1
    Solution: 11.8