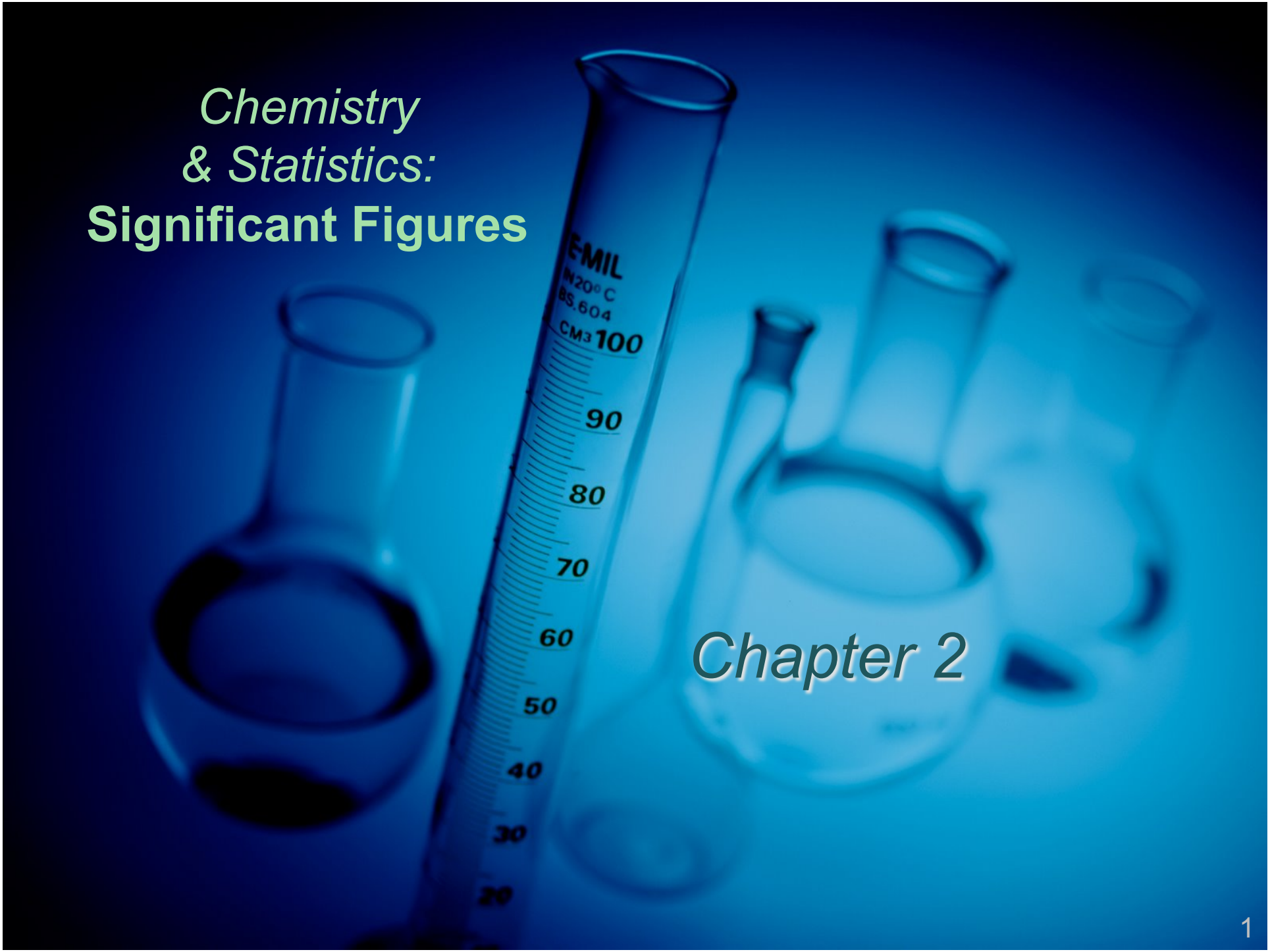
Chemistry & Statistics: **Significant Figures**



Chapter 2

Chemistry & Statistics: Significant Figures (digits)

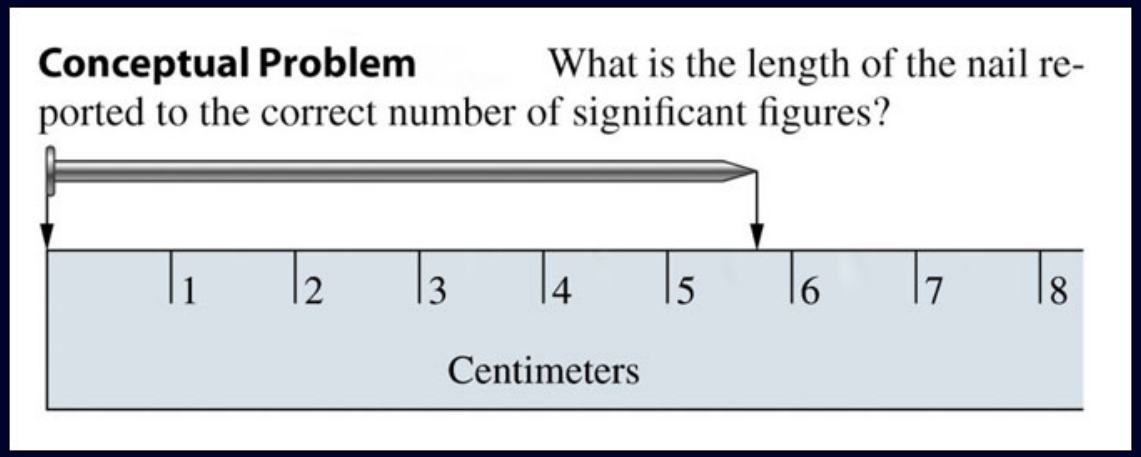
Chapter 2

- If you divide two numbers, like **1.20 g** by **0.07023 mL**, your calculator will tell you that the answer is **17.08671507903 g/mL**.
- You probably know that you should round the number, but where, and how do you decide?
  - Consider the precision of the numbers.
  - The last digit in all measurements is ***estimated*** and determines the number of significant digits in the quantity.
  - Numbers encountered in most problems are measured values with the last digit estimated.
- After considering the rules for significant figures, we will see that the answer should be rounded to: **17.1 g/mL.**

Uncertainty in Measurement

A digit that must be estimated is uncertain.

A measurement always has some degree of uncertainty.

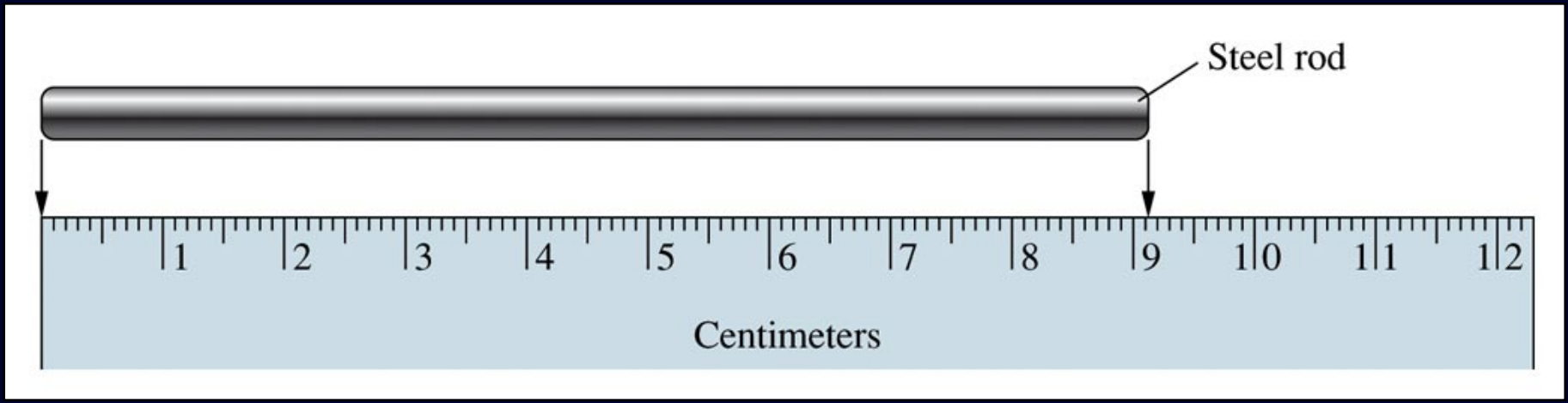


Possible Estimates:

Record:

Interpretation:

Measurement to higher precision

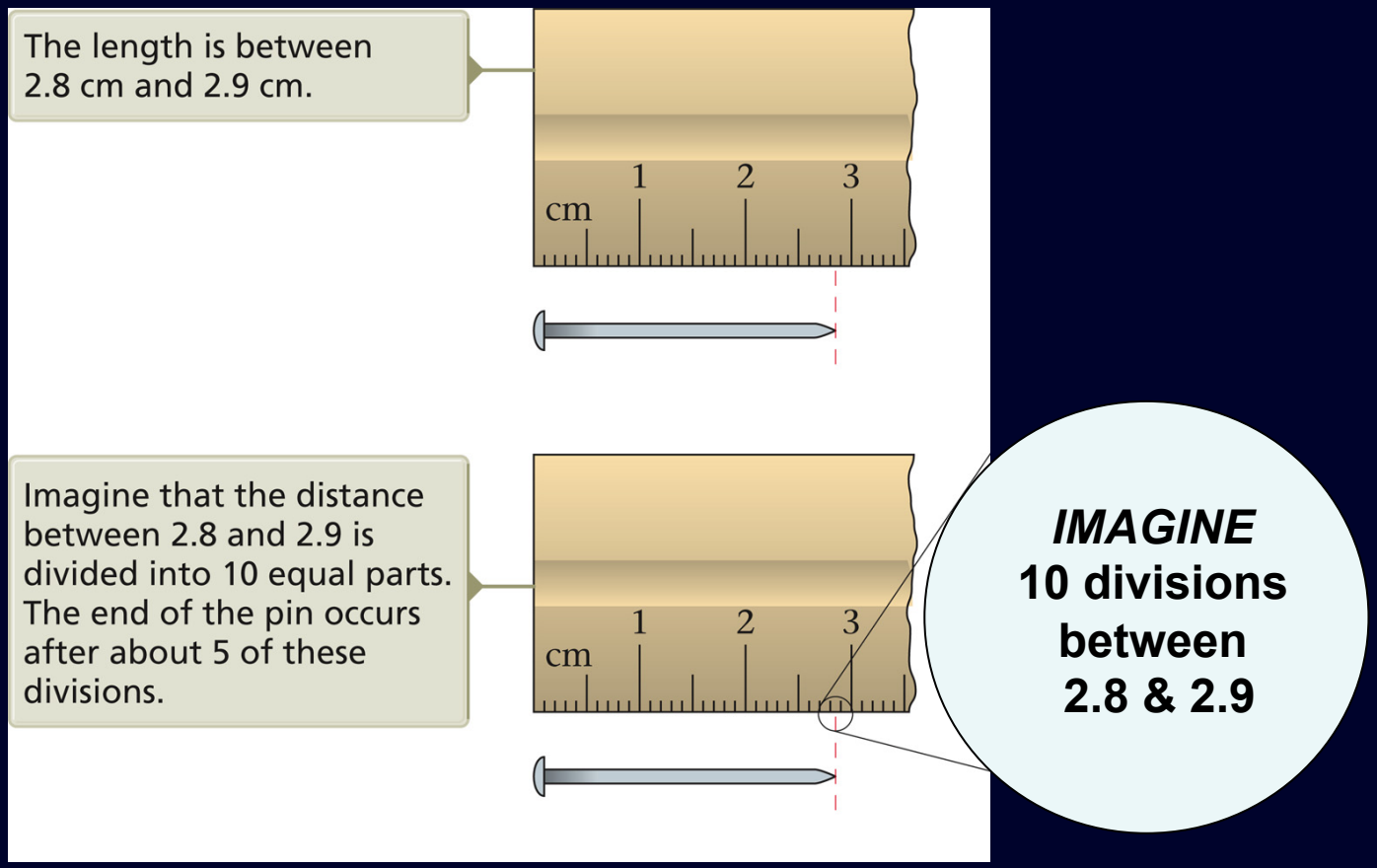


Possible Estimates:

Record:

Interpretation:

Reading a Scale



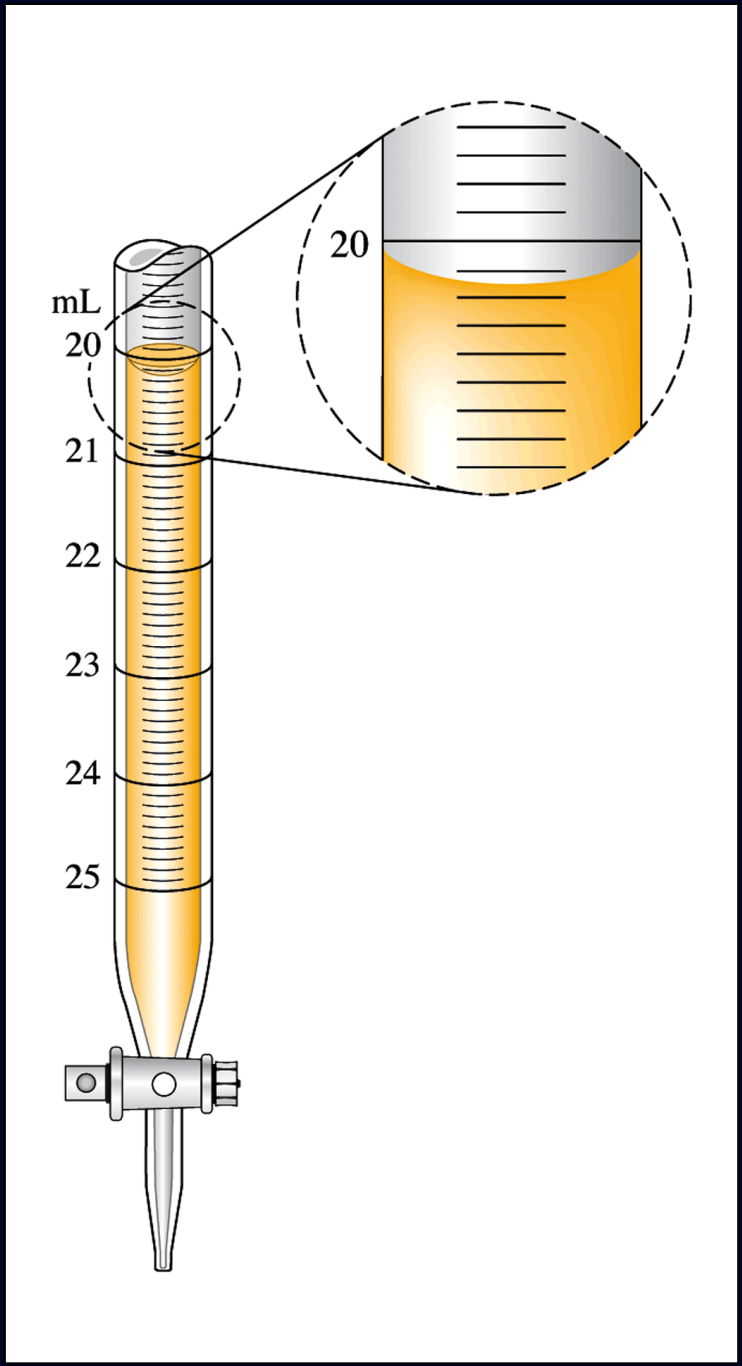
- The length of the pin occurs at about 2.85 cm.

  Certain digits: 2.85 Uncertain digit: 2.85

Estimate the volume in the buret.

Notes:

- Each division is 0.1 mL
- Volume is read at the bottom of the meniscus
- Volume markings increase from top to bottom.



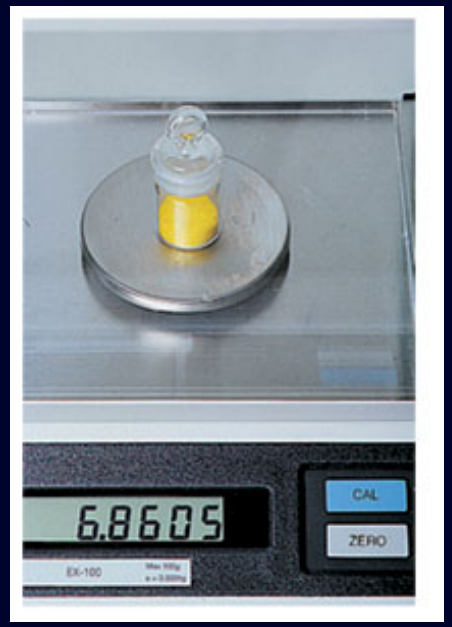
Digital Readouts and Sig Figs

- Electronic balances and other instruments with digital readouts report to you the correct number of significant digits.
- The computer estimates the last digit for you.
- You should always record all of the digits on the readout.
- For the balance on the right, the value should be recorded as:

6.8605 g

Certain digits

Uncertain (estimated) digit



Rules for counting Significant Figures:

1. All non-zero digits are significant.

2. All zeros between significant digits are significant.

3. All leading zeros are NOT significant.

4. Ending zeros are significant if the number contains a decimal point.

Sig Figs - Additional Rules

- Exact numbers and counting numbers have an infinite number of significant figures.

- In a number in which some ending zeros are significant, but others are not, a bar (above the digit) may be used to indicate the last significant zero.

- When numbers are written in scientific notation, all digits should be significant.

Rules for significant figures in calculations:

- For ***multiplication*** and ***division***, the answer will have the same number of significant digits as the quantity with the least number of significant digits.

1) 550 x 321

2) $$\frac{5.1200 \times 10^{3}}{0.002405}$$

3) $$\frac{8.84 \times 10^{-15}}{0.001232}$$

Rules for significant figures in calculations:

- For ***addition and subtraction***, in numbers that have a decimal place, the answer will have the same number of decimal places as the quantity with the fewest number of decimal places.
- In numbers with no significant decimal places, the number that has its last significant digit farthest to the left determines where the answer will be rounded (see examples).

1) 35.290 + 212.1

2) 768,350,000 – 483,200

Sig Figs - Additional Rules

- If a calculation involves many steps, do NOT round at the intermediate steps – Carry at least one or two extra significant figures to prevent the introduction of rounding errors:

CORRECT:

$$\frac{2.4 \times 6.1}{3.2} = \frac{\overline{14}.64}{3.2} = 4.\overline{5}75 = \mathbf{4.6}$$

NOT CORRECT:

$$\frac{2.4 \times 6.1}{3.2} = \frac{15}{3.2} = 4.\overline{6}875 = 4.7$$

Additional Examples: Significant figures in Calculations

1) $(6.2 + 85.60) / 11.558 =$

2) $88{,}000 + 52 =$

3) $(6.2 \times 10^3 + 3.11 \times 10^2) \times 1.10 \times 10^5 =$