Determining Significant Figures

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Uncertainty in Measurement

- A digit that must be estimated is called uncertain. A measurement always has some degree of uncertainty.

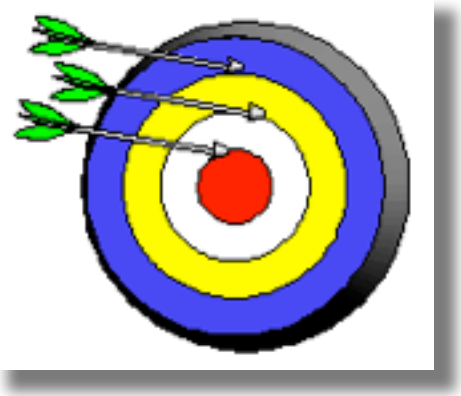
Why Is there Uncertainty?

- Measurements are performed with instruments
- No instrument can read to an infinite number of decimal places

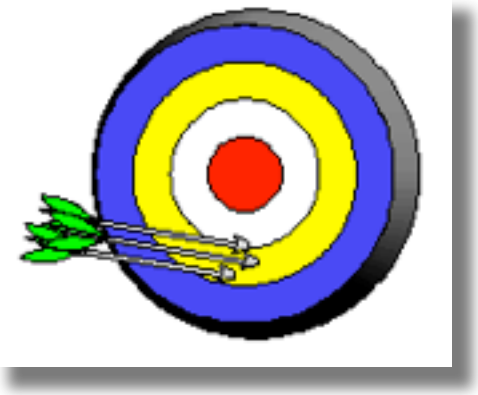
Which of these balances has the greatest uncertainty in measurement?

Precision and Accuracy

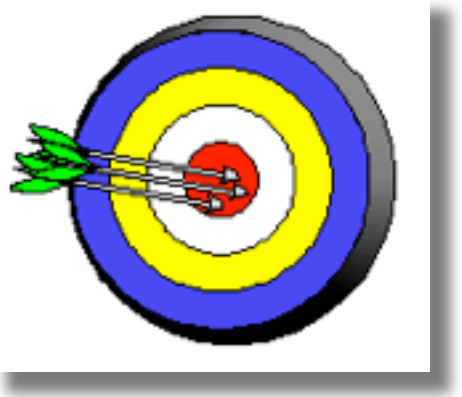
- Accuracy refers to the agreement of a particular value with the true value.
- Precision refers to the degree of agreement among several measurements made in the same manner.



Neither accurate nor precise



Precise but not accurate



Precise AND accurate

Types of Error

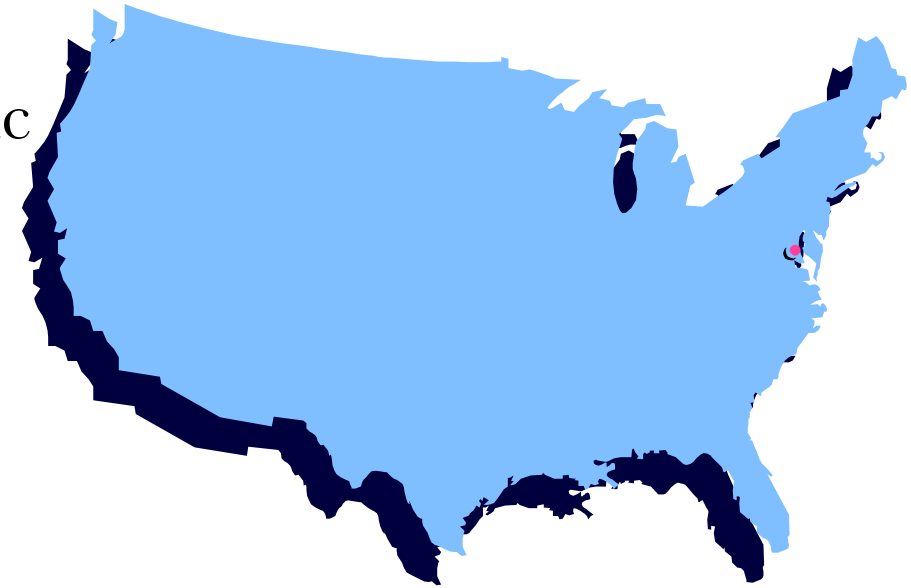
- Random Error (Indeterminate Error) - measurement has an equal probability of being high or low.

- Systematic Error (Determinate Error) - Occurs in the same direction each time (high or low), often resulting from poor technique or incorrect calibration.

DETERMINING THE NUMBER OF SIGNIFICANT DIGITS…

- The Atlantic-Pacific Rule

- Pacific



Atlantic

If a decimal point is present…

- Start at the Pacific side (left) of the number-
  - Start with the first nonzero digit and count everything from there to the extreme. These are all considered significant:
  - Ex:
    - 0.00238930 cm = 6 significant digits

If a decimal point is absent…

- Start from the Atlantic side (right side) of the number, start at the first nonzero digit and everything after that to the Pacific side is significant.
- Ex –
  - 128021600 = 7 significant digits

Practice:

1. **1.0068**
2. **.0045902**
3. **0.002905**
4. **10002**
5. **18200**
6. **.0048904**
7. **1000.400**
8. **5.0820**
9. **200.008**
10. **10000000000**

Answers:

1. 5
2. 5
3. 4
4. 5
5. 3
6. 5
7. 7
8. 5
9. 6
10. 1

Significant Digits in Calculations:.

- Multiplication & Division: Your calculated value cannot have any more digits than your least specific measurement
- Example:
- $3.0\text{m} \times 125.8\text{m} \times 710\text{m} = 267954\text{m}^3$

  2 s.f 4 s.f 2 s.f answer must be rounded to two sig figs

$= 270000\text{m}^3$

2 significant figures

Sig Fig Practice #3

Calculation	Calculator says:	Answer
3.24 m + 7.0 m	10.24 m	10.2 m
100.0 g - 23.73 g	76.27 g	76.3 g
0.02 cm + 2.371 cm	2.391 cm	2.39 cm
713.1 L - 3.872 L	709.228 L	709.2 L
1818.2 lb + 3.37 lb	1821.57 lb	1821.6 lb
2.030 mL - 1.870 mL	0.16 mL	0.160 mL

Addition & Subtraction

- Your calculated value cannot be more precise than the least precise **place value** of the measurement used in your calculation.
- Example:
- 12003cm + 56.2 cm = 12059.2 → 12059
- Since the first number is only determined to the ones place, the number is rounded to the ones place.

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Conversion Factors & Constants

- Conversion factors and constants are exact measurements.
- They DO NOT play a role in determining the number of significant figures.
- Ex: Converting within the metric system or temperature conversions – the number of significant figures is determined by the precision of the instrument used to measure.
  - °F → °C The answer will be determined by the precision of the thermometer used.