Uncertainty in Measurement: Significant Digits Key

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I. Introduction

Exact Numbers - Counted Quantities

Two Parts:

- Magnitude
- Identity

Example: 3 cows, 7 horses

Can be fractions

Inexact Numbers - Measured Quantities

Two Parts:

-Magnitude

-Scale

"Value" - depends on scale and is expressed by the number of Significant Digits

Report all certain values

Report first uncertain value

Uncertain Value is a "guess" between smallest unit of scale

Successive Measurements will vary by uncertain value

Accuracy - How close a measured value is to the true value.

Precision - How close successive measured values are to each other. The smallest the unit of a scale the more precise successive measurements.

Significant Digits - First uncertain and all certain digits of a measured number.

II. Representing Significant Digits

1. Non Zeros are always significant
2. Leading Zeros are never significant
3. Captive Zeros are always significant
4. Trailing Zeros are only significant if a number has a decimal point

A. How many significant figures do each of the following numbers contain?

a) 0.0025 in 2 b) 300.1 ft 4 c) 872.20 mile 5

d) 4640.0 g lb 5 e) 8000 Oz 1 f) 120 pens not appropriate

III. Significant Digits in Calculations

1. Round Off (Truncation) Rules

1. Round Up if the second uncertain digit is greater than or equal to 5.
2. Round down if the second uncertain digit is less than 5.

2. Addition and Subtraction

-Result is limited to precision of least precise measurement
(determined by the largest uncertain digit)

You can not do this by sight but actual need to do the math (see examples).

101-99 = 2

(A number with 2 sig figs subtracted from a number with 3 sig figs gives a difference with one sig fig).

3. Multiplication and Division

-Result is limited to the number of significant figures of the value with the least number of significant figures.

101 X 99 = 9999=9,900

4. Compound Calculations

Use all digits during intermittent steps and only truncate the final answer. You have to manually determine the number of significant digits of intermediate addition or subtraction steps (but use all digits in subsequent calculations).

Example:

$$\frac{99.0g}{1g+99g}=0.990$$

The answer has three sig figs because of the rules for addition in the denominator gives that value 3 sig figs.

Example showing why you can not truncate during intermediate steps:

Example: (correct solution)
(1.89 + 1.55 + 1.0) x 7.55 =
4.44 x 7.55=33.522=34

(We used all sig. figs in the intermediate step although 4.44 has only 2 from the rules for addition). Then used that knowledge to truncate the final answer to 2 significant digits (that is, we knew from the intermediate step that the value of that answer had only 2 sig. figs, even though we used 3 in doing the math).

Wrong way (truncate early)
(1.89 + 1.55 + 1.0) x 7.55 =
4.4 x 7.55 = 33

(which is the wrong answer as we made the mistake of truncating the summation value of the intermediate step.

B. Perform the following operations, recording the final answer to the correct number of significant figures. (Consider all values to be measured):
   a) (138.61)(3.29) = 456
   b) 29.03 – 2.6 = 26.4
   c) (5.90)(8.215) = 48.5
   d) 2.039 + 25.76 + 0.295 = 28.09
   e) 2.97 / 0.012 = 250
   f) 2.00 + 4.00 + 7.00 + 10.00 = 23.00
   g) 99.0 / (99+1) =0.990