Chapter 1

Measurements

Significant Figures in Calculations

Significant Figures in Measurement

- The numbers reported in a measurement are limited by the measuring tool.

- Significant figures in a measurement include the known digits plus one estimated digit.

a
3   4   5   cm

What are the 'read' numbers? 4.7

What is the estimated number? 4.78

What is the complete measurement? **4.78** cm

Counting Significant Figures

Number of Significant Figures

38.15 cm	**4**
5.6 ft	**2**
65.6 lb	___
122.55 m	___

All non-zero digits in a measured number are significant.

Leading Zeros

Number of Significant Figures

0.008 mm	1
0.0156 oz	3
0.0042 lb	____
0.000262 mL	____

Leading zeros in decimal numbers (zeroes to the left of the first non zero digit) are not significant.

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Sandwiched Zeros

Number of Significant Figures

50.8 mm	3
2001 min	4
0.702 lb	____
0.00405 m	____

Zeros between nonzero numbers are significant.

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Trailing Zeros

Number of Significant Figures

25,000 in.	2
200 yr	1
48,600 gal	3
25,005,000 g	____

Trailing zeros in numbers without decimals are not significant if they are serving as place holders.

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Scientific Notation

- Zeros to the left of a decimal can be confusing. Scientific notation is therefore used to denote the number of significant figures.

- **Scientific notation** is a convenient system to express very large and very small numbers in the form: **N x 10^n**

  - *N* (coefficient) is a number between 1 and 10.
  - *n* (exponent) is a positive or negative integer (whole number).
  - e.g. 1000 = 1.00 x 10^3 (always use 3 sig. fig.)

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Learning Check

A. Which answers contain 3 significant figures?
  1) 0.4760   2) 0.00476   3) 4760

B. All the zeros are significant in
  1) 0.00307   2) 25.300   3) 2.050 x 10^3

C. 534,675 rounded to 3 significant figures is
  1) 535   2) 535,000   3) 5.35 x 10^5

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Solution

A. Which answers contain 3 significant figures?
  2) 0.00476   3) 4760

B. All the zeros are significant in
  2) 25.300   3) 2.050 x 10^3

C. 534,675 rounded to 3 significant figures is
  2) 535,000   3) 5.35 x 10^5

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Learning Check

In which set(s) do both numbers contain the *same* number of significant figures?

1) 22.0 and 22.00

2) 400.0 and 40

3) 0.000015 and 150,000

Solution

In which set(s) do both numbers contain the *same* number of significant figures?

3) 0.000015 and 150,000

Learning Check SF3

State the number of significant figures in each of the following:

A.   0.030 m   1   2   3

B. 4.050 L   2   3   4

C. 0.0008 g   1   2   4

D. 3.00 m   1   2   3

E. 2,080,000 bees   3   5   7

Solution

A. 0.030 m   2

B. 4.050 L   4

C. 0.00008 g   1

D. 3.00 m   3

E. 2,080,000 bees   3

Zeroed Numbers

A decimal point at the end of a zeroed number always denotes an exact number. All numbers are significant:

10000. – 5 Sig Fig
100. – 3 Sig Fig
10. – 2 Sig Fig

Significant Figures in Calculations

- A calculated answer cannot be more precise than the measuring tool.

- A calculated answer must match the least precise measurement.

- Significant figures are needed for final answers from
    1) adding or subtracting
    2) multiplying or dividing

Adding and Subtracting

- The answer has the same number of decimal places as the measurement with the fewest decimal places.

  25.2 *one decimal place*

  + 1.34 *two decimal places*

  26.54

  answer 26.5 *one decimal place*

Learning Check

In each calculation, round the answer to the correct number of significant figures.

A. 235.05 + 19.6 + 2.1 =
   1) 256.75   2) 256.8   3) 257

B.   58.925 - 18.2   =
   1) 40.725   2) 40.73   3) 40.7

Solution

A. 235.05 + 19.6 + 2.1 =
   2) 256.8

B.   58.925 - 18.2   =
   3) 40.7

Multiplying and Dividing

- Round (or add zeros) to the calculated answer until you have the same number of significant figures as the measurement with the fewest significant figures.
- The answer cannot have more significant figures than the least number present in the problem:

10.52/7.3 – 2 Sig Fig

Learning Check

A. 2.19 X 4.2 =
   1) 9   2) 9.2   3) 9.198

B. 4.311 ÷ 0.07 =
   1) 61.58   2) 62   3) 60

C.   2.54 X 0.0028 =
    0.0105 X 0.060
    1) 11.3   2) 11   3) 0.041

Solution

A.   2.19 X 4.2   =   2) 9.2
B.   4.311 ÷ 0.07 =   3)   60

C.   2.54 X 0.0028 =   2) 11
      0.0105 X 0.060

   Continuous calculator operation =
   2.54   x 0.0028   ÷   0.0105 ÷   0.060