Chem Math Review

The following topics will be discussed during this unit:

" Significant Digits or Figures

" Exponential or Scientific Notation

" Metric System (International System of Units, or *SI* units)

" Dimensional Analysis

Chemistry is an Experimental Science

As such, much of our discussion will deal with working with measurements (numbers) intelligently.

Some Basic Definitions

Precision refers to the degree of reproducibility of a measured quantity, that is, the closeness of agreement when the same quantity in measured several times.

	Platform Balance	Analytical Balance
Three Measurements	10.4 g. 10.2 g. 10.3 g.	10.3107 g. 10.3108 g. 10.3106 g.
Their Average	10.3 g.	10.3107 g.
Reproducibility	±0.1 g.	±0.0001 g.
Precision	low	high

Accuracy - Refers to how close a measured value is to the accepted or "***real***" value. High precision numbers are not always accurate. But it more likely that measurements of high precision are more accurate.

Percent Error

$$\text{Percent Error} = \frac{\text{Difference between the experimental value and the accepted value}}{\text{the accepted value}} \times 100$$

For example, if you measure the mass of oxygen in a sample to be 25.0 grams and the theoretical value is 30.0 grams, the percent error would be:

$$\text{Percent error} = \frac{30.0\text{ g.} - 25.0\text{ g.}}{30.0\text{ g.}} \times 100$$

$$= \frac{5.0\text{ g.}}{30.0\text{ g.}} \times 100 = 17\ \%\text{ error}$$

Significant Digits or Figures

Except where integers are involved (for example, in counting the number of students in a class), it often impossible to obtain the exact value of the quantity under investigation. For this reason, it is important to indicate the margin of error in a measurement by clearly indicating the ***significant digits***, which are the meaningful digits in a measured or calculated value.

When significant digits are counted, the last digit is understood to be uncertain.

Given the calculation:

$$\frac{56}{13.33} = 4.201050263 \quad \left\{ \begin{array}{c} \text{Answer given on} \\ \text{the calculator} \end{array} \right.$$

What number would you write as your answer on your answer sheet?

$$\frac{56}{13.33} = 4.201050263$$

The last digit in a number
is always uncertain

A change in the second digit in the number “56" changes the second digit in your answer.

$$\frac{57}{13.33} = 4.276069017$$

A change in the fourth digit in the number “13.33" changes the fourth digit in your answer.

$$\frac{56}{13.34} = 4.197901049$$

Rules for Significant Digits

All digits of a number that are known to be reasonably reliable are known as significant digits.

1. All non-zero digits are significant digits.

   788 = 3 sd, 5 = 1 sd, 89319 = 5 sd

2. Zeros between non-zero digits are significant.

   2001 = 4 sd, 3208 = 4 sd, 101 = 3 sd

3. If the sole purpose of the zero is to place the decimal point, the zero is not a significant digit.

24000 = 2 sd, 0.34 = 2 sd, 0.00002 = 1 sd

4. If the zero shows precision, it is a significant digit.

   1.00 = 3 sd, 40.00 = 4 sd, 0.700 = 3 sd

5. Integers (numbers arrived at by counting or by definition) have an infinite number of significant digits.

   100 students = 4 sd, 100 miles = 1 sd
   4 books = 4 sd, etc.

6. A decimal point may be used to make zeros significant digits.

   100. = 3 sd, 72,900. = 5 sd

7. In exponential numbers, only the numeric portion of the number may be used when considering the number of significant digits. The exponential portion places the decimal point and therefore is not significant.

   1.03×10^{20} = 3 sd, 3×10^{101} = 1 sd

DRILL

Give the correct number of significant digits in each of the following numbers:

6,000,000	________
200.	________
0.040	________
3.000	________
22,901,000	________
0.880	________
700 pennies	________
1.200×10^{100}	________
390.000	________
1200 liters	________

Finding the Number of Significant Digits

Simplified Method

How many significant digits in the numbers?

807,000	0.0068310

â Find the decimal point.

807,000	0.0068310

ã Move to the first non-zero digit.

807,000	0.0068310

ä The remaining digits are significant.

807,000	0.0068310
3 significant digits	5 significant digits

What if the decimal point is already there?

10.00	80,000.

They are all significant!

10.00	80,000.
4 significant digits	5 significant digits

Give the number of significant digits in each of the following numbers:

340,000	0.00340
21.000	300,050.
90.31	450,000,000
0.00601	0.2020

Rounding

When rounding numbers, the placement of the decimal point does not change, only the number of significant digits.

Round the number 4.2010503 to two significant digits.

â Count off two significant digits.

4.2010503

ã If the remainder is less than half, delete the remainder.

If the remainder is greater than or exactly equal to half, add one to the right most significant digit.

Since the remainder is less than half, it is deleted, and the answer becomes 4.2.

Round the number 45.8745 to three significant digits.

45.8745

The answer is 45.9 since the remainder after counting off three digits is greater than half.

Round each of the following numbers to three significant digits:

892,300	0.21563
902,345,000	35.992
8345	675499

<u>Significant Digits in Numerical Calculations</u>

The best guideline for the use of significant digits in calculations is common sense. It is common sense that a calculated result *can be no more precise than the least precise piece on information* that went into the calculation.

The result of multiplication and/or division "*type*" problems **must** contain only as many significant digits as the *least* precisely known quantity in the calculation.

For example, find the answer to the following calculation expressing your answer with the correct number of significant digits.

$$14.79 \text{ x } 5.05 \text{ x } 21 = 1568.4795$$

$$\underset{\text{4 sign. digits}}{14.79} \text{ x } \underset{\text{3 sign. digits}}{5.05} \text{ x } \underset{\text{2 sign. digits}}{21}$$

Answer = 1600

Calculate the answer to the following problem expressing your answer to the correct number of significant digits.

$$\frac{56}{7.00} = 8$$

$$\frac{2 \text{ s.d.} \rightarrow 56}{3 \text{ s.d.} \rightarrow 7.00} = 8$$

answer must have
2 sign. digits

Answer = 8.0, two significant digits.

Calculate the following problem expressing your answer to the correct number of significant digits.

$$\sqrt{64} = 8$$

Answer = 8.0 since 64 has two significant digits, the answer must have two significant digits.

Calculate the answer in each of the following problems expressing your answer to the correct number of significant digits.

â $36 \times 200 = 7200$ __________

ã $\frac{125}{5} = 25$ __________

ä $\sqrt[3]{27.0} = 3$ __________

å $(4)^2 = 16$ __________

æ $\frac{40.0 \times 25}{50.00} = 20$ __________

ç $(6.0)^3 = 216$ __________

The result of addition and/or substraction *"type"* problems **must** be expressed with the same number of decimal places as the quantity carrying the *smallest* number of decimal places.

In addition and substraction problems, it is not the number of significant digits in each operator which determine the number of significant digits in your answer, but the number of columns containing only significant digits.

Consider the sum:

$$\begin{array}{r} 15.02 \\ 9{,}986.0 \\ 3.518 \\ 10{,}004.538 \end{array}$$

The answer is 10,004.5 since 9,986.0 has the smallest number of decimal places.

Perform the indicated operation expressing your answer with the correct number of significant digits:

â

$$\begin{array}{r} 153.4 \\ -\ 2.51 \\ 150.89 \end{array}$$

____

ã

$$\begin{array}{r} 2.66 \\ +\ 1001. \\ +\ 0.0023 \\ +\ 17.2 \\ 1020.8623 \end{array}$$

____

ä

$$\begin{array}{r} 5.02 \\ +\ 440.0 \\ +\ 113.1417 \\ 558.1617 \end{array}$$

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Perform the indicated operation expressing your answer with the correct number of significant digits:

â $15 \times 2.01 \times 3.000 = 90.45$ __________

ã $\begin{array}{r} 80 \\ +\ 27.2 \\ \hline 107.2 \end{array}$ __________

ä $\dfrac{36.0 \times 8.0}{144} = 2$ __________

å $\sqrt{36} = 6$ __________

æ $(2.00)^4 = 16$ __________

ç $\begin{array}{r} 516 \\ +\ 40 \\ \hline 556 \end{array}$ __________