CHEM 101 – Significant Figures

Significant Figures – The digits in a number that are certain *plus* one more (uncertain) digit.

Someone tells you their salary is $55,000 per year, but it's likely they don't make *exacty* $55,000. They might make $54,755.35 or $56,324.15. So we say that number has only **two significant figures**. Note how the second 5 could be a 4 or a 6, but it is *near* 5.

<u>ZEROS AS SIGNIFICANT FIGURES</u>

Some zeros are *zeros* but some zeros are just place-holding zeros. These zeros are *important*, but they may *not* significant figures.

Non-zeros – Always significant.

Leading Zeros – Are not significant. Never. Examples:

0.005542	(4SF) three leading zeros not SF, last 4 digits are SF
0.154	(3SF) zero before the decimal is a leading zero and **not** SF, and the 3 following digits are SF
004445.0	(5SF) 2 unnecessary leading zeros are **not** SF, and all the following digits are SF (see Trailing Zeros below)

"In-Between" Zeros – Are significant. Always. Examples:

3,045.3	(5SF) Zero is between non-zeros
0.00504	(3SF) Note: leading zeros **not** SF
1.0204	(5SF) Both zeros are in between non-zeros and thus SF
10.003	(5SF) All zeros here are in between thus SF

Trailing Zeros – Depend on whether or not there is a decimal point. Examples:

0.0500	(3SF) Leading zeros **not** SF, and trailing zeros are SF because decimal point
6.0050	(5SF) The sole trailing zero is SF, along with the other digits
55,000	(2SF) Here is where the trailing zeros are **not** SF, as there is no decimal point.
55,000.	(5SF) Now we have a decimal point so trailing zeros are SF
10.000	(5SF) All zeros trailing and there is a decimal point.
0.00005	(1SF) These are leading zeros. Only apply decimal condition to TRAILING ZEROS

ROUNDING

There are *DIFFERENT* sets of rules, for *1) MULTIPLYING AND DIVIDING*, *2) ADDITION AND SUBTRACTION*, and *3) LOGARITHMS & EXPONENTIATION*

Multiplying and Dividing

When we multiply and divide, we round the answer to the number of significant figures as the number in the calculation with **the fewest** significant figures. Examples:

1) $\underset{3SF}{(4.55)}\times\underset{2SF}{(0.0054)}/\underset{4SF}{0.004459} =$ $5.510204082 = \boxed{5.5}$ (2SF)
round to 2SF (fewest)

2) $$\frac{\overset{5SF}{3{,}040.3}\times\overset{5SF}{7.1999}}{\underset{4SF}{0.0004010}\times\underset{3SF}{2.00}} = 27\underline{2}94084.75 = \boxed{27{,}300{,}000}\ \text{(3SF)}$$

Adding and Subtracting

When we add and subtract, we compare the decimal place of the **last** significant figure of each number. We round the answer to the **least accurate decimal place**. In other words, the answer is rounded by decimal place, not by significant figures. Examples:

1) $\underset{\text{(tenth place)}}{104.\underline{3}} + \underset{\text{(hundredth place)}}{17.9\underline{9}} + \underset{\text{(ten thousandth place)}}{22.465\underline{9}} = 144.\underline{7}559 = \boxed{144.8}$ (tenth place)

It may be easier to see if we stack the numbers, lining up the decimal:

$$\begin{array}{r} 104.\underline{3} \\ 17.9\underline{9} \\ +\ 22.465\underline{9} \\ \hline 144.\underline{7}559 \\ = \boxed{144.8} \end{array}$$

Tenth place is least accurate

2) $304.22\underline{3} - 9.994\underline{9} + 0.0\underline{5} = 294.2\underline{7}81 = \boxed{294.28}$ (hundredth place)

Logarithm and Exponentiation

When we take a logarithm, the answer has **one more** SF. When we exponentiate, the answer has **one fewer** SF.

1) $\log(4.55) = 0.658\underline{0}114 = \boxed{0.6580}$ (4SF—one more SF than 4.55)
2) $\ln(0.0035) = -5.6549923 = \boxed{-5.65}$ (3SF—one more than 0.0035)
3) $10^{-8.80} = 1.\underline{5}848931\times10^{-9} = \boxed{1.6\times10^{-9}}$ (2SF—one fewer than -8.80)