

CHEM 106 – 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 *exactly* \$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.

ZEROS AS SIGNIFICANT FIGURES

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 *TWO DIFFERENT* sets of rules, one for *MULTIPLYING AND DIVIDING*, and one for *ADDITION AND SUBTRACTION*.

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:

$$1) \quad \begin{array}{ccc} 3\text{SF} & 2\text{SF} & 4\text{SF} \\ (4.55) \times (0.0054) / 0.004459 = & & 5.510204082 = \boxed{5.5} (2\text{SF}) \\ & & \text{round to 2SF (fewest)} \end{array}$$

$$2) \quad \begin{array}{ccc} 5\text{SF} & 5\text{SF} & \\ 3,040.3 \times 7.1999 & & \\ \hline 0.0004010 \times 2.00 & = & 27294084.75 = \boxed{27,300,000} (3\text{SF}) \\ 4\text{SF} & 3\text{SF} & \end{array}$$

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:

$$1) \quad \begin{array}{ccc} 104.\underline{3} & + & 17.\underline{99} & + & 22.\underline{4659} & = & 144.\underline{7559} & = & \boxed{144.8} & (\text{tenth place}) \\ \text{(tenth place)} & & \text{(hundredth place)} & & \text{(ten thousandth place)} & & & & & \end{array}$$

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

$$\begin{array}{r} 104.\underline{3} \\ 17.\underline{99} \\ + 22.\underline{4659} \\ \hline = 144.\underline{7559} \end{array} \quad \begin{array}{l} \text{Tenth place is least accurate} \\ \curvearrowright \end{array}$$

$$2) \quad 304.\underline{223} - 9.\underline{9949} + 0.\underline{05} = 294.\underline{2781} = \boxed{294.28} \quad (\text{hundredth place})$$

$$3) \quad \underline{79,000} + \underline{5} = \underline{79,005} = \boxed{79,000} \quad (\text{thousands place})$$