Name: ___________________________ *Chemistry*

Date: _______________ Period: ______ POGIL: Sig Figs in Calculations

WHY?
Many of the measurements a scientist makes in lab are further analyzed or used to calculate derived units, such as area, speed, and pressure. When performing calculations with your measurements, your results must maintain the accuracy and precision of the original measurements. This is accomplished through significant figure calculation rules.

SUCCESS CRITERIA:
- Perform addition and subtraction problems using proper significant figure rules and rounding.
- Calculate multiplication and division problems using proper significant figure rules and rounding.

PREREQUISITES:
- Identification of significant figures in a measurement.
- Proper rounding method.

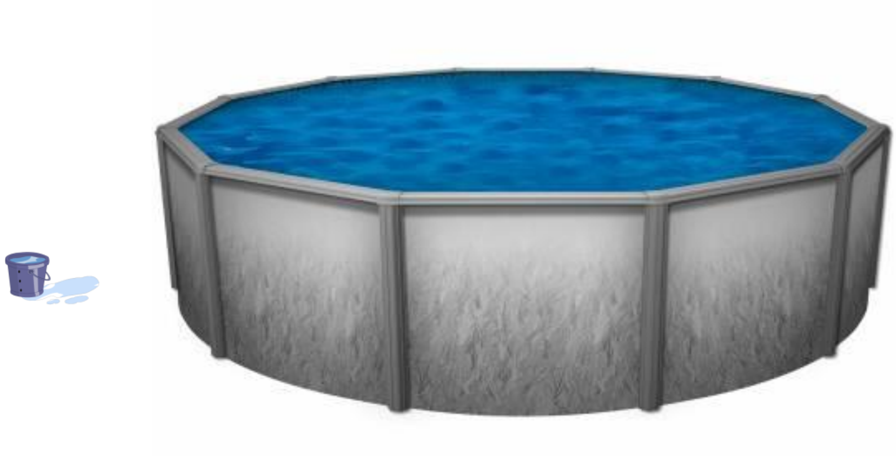
REVIEW:

1. Underline the significant figures in the following measurements:
   a. 918.010 b. 0.0001 c. 8120
   d. 91010 e. 91010.0 f. 1090.000

2. Round the following numbers to FOUR significant figures.
   a. 2.16347×10^5 = ______________________________
   b. 7.2518 = ______________________________
   c. 4.000574×10^6 = ______________________________
   d. 375.6523 = ______________________________
   e. 3.6825 = ______________________________
   f. 21.865001 = ______________________________
   g. 898.779 = ______________________________

Model 1: Using Significant Figures in Addition and Subtraction

Did you know that 30,000 plus 1 does not always equal 30,001? In fact, 30,000 + 1 is sometimes equal to 30,000! You may find this hard to believe, but let’s examine this.



Recall that zeros in a number are not always significant. Knowing this makes a big difference in how we add and subtract. For example, consider a swimming pool that can hold 30,000 gallons of water. If I fill the pool to the maximum fill line and then go and fill an empty one gallon milk jug with water and add it to the pool, do I then have exactly 30,001 gallons of water in the pool? Of course not.

I had approximately 30,000 gallons before, and after I added the additional gallon because 30,000 gallons is not a very precise measurement. So we see that sometimes 30,000 + 1 = 30,000!

In mathematical operations involving significant figures, the answer is reported in a way that reflects the reliability of the least precise number. An answer is no more precise that the least precise number used to get the answer.

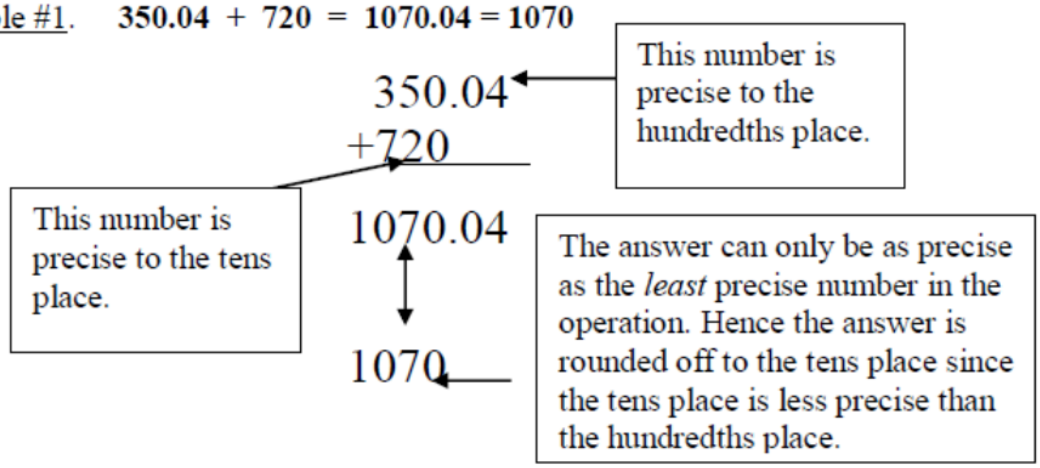
Imagine a team race where you and your teammates must finish together at the same time. Who dictates the speed of the team? The slowest member of the team, of course. Your answer cannot be MORE precise than the least precise measurement.

Use the “Decimal Rule” when adding and subtracting numbers:

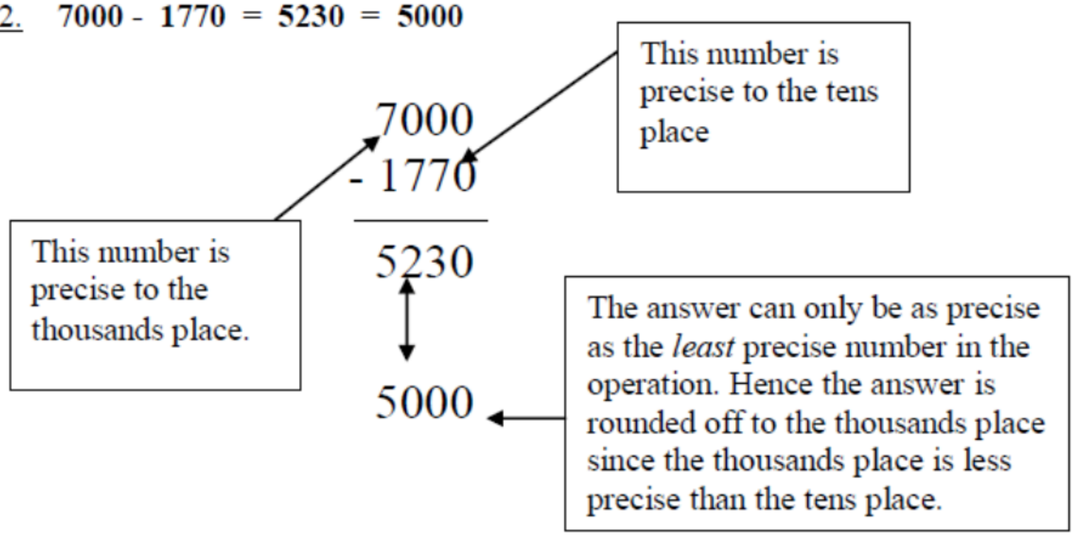
For **addition or subtraction**, the answer must be rounded off to contain only as many decimal places as are in the value with the ***least*** number of decimal places.

<u>WARNING!!</u> The rules for addition/subtraction are different from those of multiplication/division. A very common student error is to swap the two sets of rules. Another common error is to use just one rule for both types of operations.

Example #1. **350.04 + 720 = 1070.04 = 1070**



Example #2. **7000 - 1770 = 5230 = 5000**



Key Questions

3. Consider example #1 from above. Indicate in the spaces below the number of significant figures (sf) for each number in the problem.

350.04	+	720	=	1070.04	=	1070
_____sf		_____sf		_____sf		_____sf

Should the number of significant figures be considered when adding or subtracting measured numbers? Explain

4. When you add and subtract numbers, how do you identify the first uncertain number in the result?

Practice

Record the answer before and after rounding to the proper place value.

5. 3.461728 + 14.91 + 0.980001 = ____________________ = ____________________

6. 23.4 + 4.77 + 125.39 + 3.581 = ____________________ = ____________________

7. 564,300 – 264,321 = ____________________ = ____________________

8. 22.101 – 5.93 = ____________________ = ____________________

Model 2: Using Significant Figures in Multiplication and Division

A chain is no stronger than its weakest link—that is, an answer is no more precise that the least precise number used to get the answer.

Use the "Chain Rule" when multiplying and dividing measured numbers:

> When measurements are multiplied or divided, the answer can contain no more significant figures than the number with the fewest number of significant figures. This means you MUST know how to recognize significant figures in order to use this rule.

To round correctly, follow these simple steps:

1) Count the number of significant figures in each number.
2) Round your answer to the least number of significant figures.

<u>Example #1</u>.

$$\frac{4560}{14} = 325.714285714 = 330$$

4560 ← 3 sig figs

14 ← 2 sig figs

330 ← The rounded answer has only 2 significant figures since 2 is the least number of significant figures in this problem.

<u>Example #2</u>.

$$13.1 \times 1.2039 = 15.77109 = 15.8$$

13.1 ← 3 sig figs

1.2039 ← 5 sig figs

15.8 ← The rounded answer has 3 significant figures since 3 is the least number of significant figures in this problem.

***Multi-Step Calculations with Multiplication/Division:* do not round until the end**. For example, if a final answer requires two significant figures, then carry at least three significant figures in all calculations. If you round-off all your intermediate answers to only two digits, you are discarding the information contained in the third digit, and as a result the second digit in your final answer might be incorrect. This phenomenon is known as "round-off error." Avoid rounding errors by carrying at least on extra sig fig throughout a multi-step calculation and then round off to the correct number of sig figs at the very end.

Key Questions

9. When you multiply and divide numbers, what is the relationship between the number of significant figures in the result and the number of significant figures in the numbers in your measurements?

Practice

10. Record the answer before and after rounding off for each problem below.

a. $(3.4617 \times 10^{7}) \div (5.61 \times 10^{-4}) =$ ______________________ = ______________________

b. $[(9.714 \times 10^{5})(2.1482 \times 10^{-9})] \div [(4.1212)(3.7792 \times 10^{-5})] =$

______________________ = ______________________

c. $(4.7620 \times 10^{-15}) \div [(3.8529 \times 10^{12})(2.813 \times 10^{-7})(9.50)] =$

______________________ = ______________________

d. $[(561.0)(34{,}908)(23.0)] \div [(21.888)(75.2)(120.00)] =$

______________________ = ______________________