Purpose: The purpose of this assignment is to evaluate certain mathematical concepts that will be important during our study of Physics. This will allow you to self-assess your current understanding of the concepts, as well as, give me an idea of your current level of understanding.

Objectives:

1. Perform calculations using the correct number of significant figures.
2. Convert numbers between standard form and scientific notation.
3. Convert quantities among the English system of units, the metric system, and the SI system of units.
4. Apply previously learned math concepts to given situations.

I. Significant Figures

Significant figures are all the known numbers in a measurement plus <u>one estimated</u> digit. Significant figures are important for accurate and precise measurements. Final answers to all calculations in this class will be expected to be in the correct number of significant figures.

Rules for determining Significant Figures:

1. All nonzero numbers are considered significant. (ex. Every number 1-9)
2. Zeros that are between two nonzero numbers are significant. (ex. 305)
3. Zeros at the end of a number and to the right of a decimal are significant. (ex. 23.0, 67.20)
4. Zeroes that are place holders are **<u>not</u>** significant. Left most zeros appearing in front of nonzero numbers. (ex. 0.0024, 1400)
5. Conversion factors have an unlimited number of significant figures. When using a conversion factor you determine the number of significant figures by using the original quantity that you are converting. For example, if you convert **2.3** feet to meters the conversion factor is 1 m = 3.28 ft. Your answer should contain only two significant figures since the original number, **2.3**, contains only two significant figures.

- The number **305** contains three significant figures: 3 and 5 are significant due to rule #1; the zero is significant due to rule #2.
- The number **23.0** contains three significant figures: 2 and 3 are significant due to rule #1; the zero is significant due to rule #3.
- The number **0.0024** contains only two significant digits. The zeros are place holders (rule #4), while the digits 2 and 4 are significant due to rule #1.
- The number 1400 contains only two significant digits. The zeroes are place holders (rule #4), while the digits 1 and 4 are significant due to rule #1.

Significant Figure Rules of Addition and Subtraction:

The significant figures for your answers are determined by the number of decimal places present in your original numbers. For example, you add **1.52** to **7.1**. The answer from your calculator will read **8.62**; however, the correct answer using significant figures can only have one decimal place. This answer should be rounded to **8.6** in order to satisfy significant figure rules. The same rules apply to subtraction. When subtracting **43** from **67.8** would result in an answer of **24.8**; however, since **43** has no decimal places your answer can have no decimal places. This answer will round to **25** in order to satisfy significant figure rules.

Significant Figure Rules of Multiplication and Division:

When determining the significant figures needed when doing multiplication or division the amount of decimal places does not matter. The number of significant figures in your answer should match the number of significant figures as the measurement with the least number of significant figures.

Examples: 76 is multiplied by **83.2** and gives a product of **6323.2**. This answer must be rounded to satisfy significant figure rules. Since the number **76** has the least number of significant figures, our answer must contain the same number of significant figures as **76** – two. In order to achieve this our answer must be rounded to **6300**
The same rule applies for division, so when dividing **56** by **2.33** we get an answer of **24.03433476**. That answer is <u>ridiculous</u> and demonstrates the importance of working in significant figures. Our final answer should be rounded to **24**. An answer of **24** contains the same number of significant digits as **56**. Remember the number of decimals places is not important for multiplication and division.

Use the above rules and demonstrations to complete the Significant Figures portion of the assignment found at the end of this document.

II. Scientific Notation

Scientific notation is often used in science to make working with very small or very large numbers easier. It is not practical to write out numbers like **0.00000000028** or **1,300,000,000** – scientific notation gives us another way to represent the same number.

A number given in scientific notation consists of three parts: the coefficient, the base, and the exponent. Coefficients must be between **1.0 and 9.99999**, the base is always **x10**, and the exponent represents the number of places we have moved the decimal point in order to convert from standard form to scientific notation.

Examples:

- If we convert **0.00000000028** to scientific notation, we must first get the coefficient within the accepted range. The coefficient here would be **2.8**. The base is always **x10**, so the only thing left is identifying the correct exponent. For numbers less than 1, the exponent will always be negative. The exponent is equal to the number of decimal places we moved the decimal to get to our coefficient. For this example the exponent would be **-10**. The final answer would be written as $\mathbf{2.8\ x10^{-10}}$
- Converting **1,300,000,000** to scientific notation will use the same rules; the only difference is the exponent will be positive since the original number is greater than 1. The coefficient would be **1.3**, base **x10** and the exponent would be **9**. The final answer would be $\mathbf{1.3\ x10^{9}}$.

Use the above rules and examples to complete the scientific notation portion of assignment found at the end of this document.

III. Conversion Factors

Conversion factors are used to convert among the different systems of measurement. Any length measurement in one system can be converted to any other length measurement, no matter what the system is, as long, as we know the conversion factor or a series of conversion factors that will get us to the wanted unit. It is important to remember that the quantities being measured must be the same type of measurement. For example, a length cannot be converted to a time measurement, only other length units. Conversion factors are easily found by searching on the internet. You will become familiar with a lot of the conversion factors from repeated use. We will be using conversion factors for all metric and SI units – No more King Henry blah blah blah. Learn it the right way and it works for any set of units.

The key for a conversion factor is to set up your ratio the correct way. Use your units to assist with setting up the problem. The unit you are converting from will always be in the denominator, and the unit you are trying to convert to will always be in the numerator. Occasionally, more than one conversion factor is needed in order to get to the desired unit.

Examples:

- You are asked to solve a distance problem in meters. However, the information is given as 842 centimeters. This is an easy conversion if you know the conversion factor 1 m = 100 cm. Follow the steps written below. **(remember that conversion factors have unlimited significant figures, so your final answer must have the same number of significant figures as the original number)**

$$842 \text{ cm} \times \frac{1\,m}{100\,cm} = 8.42 \text{ m}$$ ….. notice how the cm cancel out leaving meters

- If a combination of conversion factors are needed you would set up your problem similar to the one below. We have measured an item to be 23.5 inches long. We must convert this item to meters to satisfy the problem. The conversion factors needed would be 1 in = 2.54 cm and 1 m = 100 cm.

$$23.5 \text{ in} \times \frac{2.54\,cm}{1\,in} \times \frac{1\,m}{100\,cm} = 0.597 \text{ m}$$

- If working with a derived unit (combination of units), then we must convert each unit separately. This can be achieved using one set up. Convert 55 miles per hour to meters per second. 1 mi = 1.6 km, 1 km = 1000 m, 1 min = 60 s, 1 hr = 60 min

$$55\,\frac{mi}{hr} \times \frac{1.6\,km}{1\,mi} \times \frac{1000\,m}{1\,km} \times \frac{1\,hr}{3600\,s} = 24 \text{ m/s}$$

Notice that the mi → meter conversion was done first, then the hours to second. Remember that hours were in the denominator; that is why it shows up in the numerator during the conversion. We want it to cancel out.

- If a unit is squared or cubed, then it must be converted the correct number of times. Convert 1.5 m^3 to cm^3. You will see that we have three conversions set up to cancel out the cube.

$$1.5 \text{ m}^3 \times \frac{100\,cm}{1\,m} \times \frac{100\,cm}{1\,m} \times \frac{100\,cm}{1\,m} = 1.5 \times 10^6 \text{ cm}^3$$

Use the above examples to help you complete the conversion factor section of the assignment at the end of the document. If you do not know a conversion factor that you think you may need, look it up on the internet. Verify the conversion factor with more than one website.

Student Assignment
Complete each section using the guidelines and examples from the previous pages.

I. Significant figures: Identify the correct number of significant figures below.

1) 6.780 **2)** 0.0042 **3)** 5.2×10^3 **4)** 0.01020
5) 6030 **6)** 200 **7)** 5.60×10^{-2} **8)** 23.00

Part B: Solve each with the correct number of significant figures.
1) 56 x 4.23 **2)** 2.1 + 20.0 **3)** 87.234 – 65.7
4) 67.8 ÷ 23.2 **5)** 12 + 3.5 **6)** 11 x 34.8
7) 87 ÷ 9.335 **8)** 89 – 2.6 **9)** $1.2\times10^5 \times 6.77\times10^2$

II. Scientific notation

a. Convert the following numbers to scientific notation.
   53,400 0.00321 19 0.709 1,000,000 0.05
b. Write the following numbers in conventional form.
   1.31×10^2 6.4×10^{-2} 7.38×10^5 9.1×10^{-4}

III. Conversions
Show all of your work for the following conversions. Make sure all of your answers contain the correct number of significant figures; use scientific notation for very large or very small answers. Search for the conversion factor needed on the internet. If you cannot find a conversion factor e-mail me.

1. 52 miles to km
2. 34 ft to cm
3. 21 centuries into minutes
4. 125 lb into N (N = Newtons)
5. 32 atm into Pa

**** Metric quantities that you should memorize, make notecards for, or place on the mirror include the following: Mega, kilo, centi, milli, micro, and nano. You will need to be able to recognize the symbol for those prefixes, as well as, their values relative to the base unit of the metric system. ****