**Mathematics**

**Notes**

**Metric System**

- **The 'Metric System' is the most common system of measurement used by scientists around the world.**
- **In this class, you will be using a 'metric ruler' to measure various quantities.**
- **The 'base unit' of the metric system is the 'meter'.**
- **Adding a prefix to the meter creates a new unit.**
- **The prefixes that we will be most concerned about are the following: kilometer (km), hectometer (hm), dekameter (dam), decimeter (dm), centimeter (cm), and millimeter (mm).**

**Converting Units in the metric system**

- **To convert units in the metric system (i.e. meter to kilometer, kilometer to millimeter) involves only moving a decimal point corresponding to the place on the 'metric number line':**

**km---hm---dam---m---dm---cm---mm**

- **km = kilometer**
- **hm = hectometer**
- **dam = dekameter**
- **m = meter**
- **dm = decimeter**
- **cm = centimeter**
- **mm = millimeter**
- **For example, if we wanted to convert 100 cm into its equivalent value in kilometers, we would do the following:**
    - **Count the number of places on the 'metric number line' km is from cm.**
        - **In this case, it is five.**
    - **Move the decimal place for the number 100.0 five places to the left.**
        - **This gives us an answer of 0.001 km.**
        - **Remember, all numerical answers <u>must</u> have proper units included in your final answer.**
- **To convert 0.54 dekameters into its equivalent value in millimeters, we would move the decimal point to the right four places to give us an answer of 5,400 mm.**

**English Measuring System**

- **The measuring system commonly used in the United States is known as the 'English Measuring System'.**
  - **The United States is the only major country to use such a system.**

**Converting English to Metric Units and Vice-Versa**

- **To convert a given measurement in the metric system to its equivalent in the English system requires the use of a mathematical concept known as a 'proportion'.**
- **For example, if we wanted to convert 20 inches into its equivalent in centimeters, we would do the following:**
  - **Find the relation between inches and centimeters.**
    - **In this case it is '1 inch=2.54 centimeters'.**
  - **Now set up the proportion in the following way:**
    - $\frac{\text{1 inch}}{\text{20 inches}} = \frac{\text{2.54 centimeters}}{\text{"X" centimeters}}$
  - **Cross out the inches on the left-hand side of the equation and centimeters on the right-hand side of the equation. Remember there must be similar units on both sides of the equation.**
  - **This makes the proportion the following:**
    - $\frac{1}{20} = \frac{2.54}{\text{"X"}}$
  - **'Cross-Multiply' both sides of the equation.**
  - **The result is "X" = (20) (2.54)**
    - **The final answer is 50.8. This means that 20 inches is equivalent to 50.8 centimeters.**

**Scientific Notation**

- **Scientists use scientific notation to express large numbers in an easy-to-read format.**
- **When using scientific notation, you will see a term such as this: $10^3$. In this case the number 10 represents the base and the number 3 (which is written as a superscript), the exponent.**
- **When the number $10^3$ is written, it is literally translated to the following:**
  - **$10 \times 10 \times 10 = 10^3$.**
- **If we have a number such as 3,450,000 and convert it to scientific notation, you would do the following:**
  - **Move the decimal point to the left such that there is one number left of the decimal point.**
    - **The result is 3.450000**
  - **Then count how many times the decimal point was moved to the left.**
    - **The decimal point was moved six times.**
  - **Afterwards, we write the scientific notation**

        - **$3.45 \times 10^?$ (The zeros after 3.45 are not necessary.**
    - **The next point is determining the value of the exponent (represented by the "?").**
    - **Since the decimal point was moved six times, the value of the exponent is six, which gives us the final answer of 3.45 X 106. If you go from a higher number 3,450,000 to a smaller number 3.45 the value of the exponent is positive.**
- **If we wanted to convert the number 0.00045 to scientific notation, you would move the decimal point to the right four times (thereby increasing the value of the number). Since the value of the number increased the exponent becomes negative.**
    - **The final answer is $4.5 \times 10^{-4}$.**
- **When multiplying, the exponents are *added***
    - **For example $(3 \times 10^2)(2 \times 10^4) = 6 \times 10^6$**
- **When dividing, the exponents are *subtracted***
    - **For example $(6 \times 10^8) / (2 \times 10^4) = 3 \times 10^4$**

**Temperature Scales**

- **Scientists use three scales to indicate temperature (T), they are:**
    - **Fahrenheit (ºF)**
    - **Celsius (ºC) (Most Popular with climatologists)**
    - **Kelvin (K) (Most popular with physicists)**
        - **Note that there is no 'degree symbol' associated with the Kelvin scale.**
- **There are three formulas that can be used to convert temperatures between the Celsius, Fahrenheit, and Kelvin scales.**
    - **$F = (1.8)(C) + 32^\circ$**
    - **$C = (F - 32^\circ)/1.8$**
    - **$K = C + 273$**
        - **Note that a temperature of zero on the Kelvin scale is known as 'absolute zero'. There has never been a measured temperature of zero on the Kelvin scale.**

**Graphing**

- **Meteorological and climatological variables are plotted on graphs to help understand how they change in time or due to other reasons.**
- **The vertical line is referred to as the y-axis (or ordinate).**
- **The horizontal line is referred to as the x-axis (or abscissa).**

**Basics Statistics**

- **Climatologists use two basic statistical terms to analyze data.**

    - **Mean (Average) – Sum of all values divided by the number of values.**
        - **Find the mean of the following low temperature values in a three-day period: -2ºC, 0ºC, 5ºC.**
        - **-2ºC+0ºC+5ºC=3ºC**
        - **3ºC divided by 3 gives the mean low temperature value of one degree Celsius.**
- **The median is determined by listing the data values from highest to lowest and then determining the middle value. If there are an even amount of values, the median is determined from the mean of the middle two values.**
    - **Find the median of the following values: 4, 5, 12, 2, 1.**
        - **List values from highest to lowest: 12, 5, 4, 2, 1.**
        - **The middle value is 4 which becomes the median.**
    - **Find the median of the following values: 18, 24, (-1), 900.**
        - **List the values from highest to lowest: 900, 24, 18, (-1).**
        - **There are an even amount of values in this series.**
        - **Therefore, to find the median, you must calculate the mean of the middle two values, which are 24 and 18.**
        - **24 + 18 = 42**
        - **42 ÷ 2 = 21**
        - **Therefore the median value is 21.**

**Rounding Numbers**

- **To round numbers to the nearest decimal point:**
    - **Look to the digit to the immediate right of the place value to which you're rounding your answer.**
        - **If the digit to the immediate right is four or less, keep the same the place value to which you're rounding your final answer.**
        - **If the digit to the immediate right is five or more, increase by one the place value to which you're rounding your final answer.**
- **For example, round the number 4.4567 to the nearest tenth.**
    - **Look to the number to the immediate right of the tenths place value, which is five.**
    - **Therefore the number in the tenths place value, four is increased by one to five which makes your final answer 4.5.**
- **For example, round the number 4.4367 to the nearest tenth.**
    - **Look to the number to the immediate right of the tenths place value, which is three.**
    - **Therefore the number in the tenths place value, four remains the same to make your final answer 4.4.**

- **To round to the nearest whole number, look to the number in the tenths place value.**
    - **If the number in the tenths place value is five or more, increase the whole number place value by one.**
    - **If the number in the tenths place value is four or less, keep the whole number place value the same.**
- **For example, round the number 11.3 to the nearest whole number.**
    - **Look to the number in the tenths place value. Since it is three keep the whole number place value the same which makes your final answer 11.**
- **For example, round the number 19.8 to the nearest whole number.**
    - **Look to the number in the tenths place value. Since it is eight, increase the whole number place value by one, which makes your final answer 20.**
- **A special note to be made is that if your final answer is between zero and one [or zero and negative one] always place a zero to the left of the decimal point because sometimes the decimal point is not visible to the person looking at what you wrote down.**
    - **Therefore if you have an answer of .4, make it 0.4 so that the decimal point becomes more apparent.**

## Order of Operations

- **In a mathematical problem in which there are two or more operations involved, a question arises as to which operation comes first.**
- **The correct order involves 'PEMDAS' in which:**
    - **'P' = Parentheses**
    - **'E' = Exponents**
    - **'M' = Multiplication**
    - **'D' = Division**
    - **'A' = Addition**
    - **'S' = Subtraction**
- **The operations in parentheses always comes first followed by exponents, so on and so forth until the last operation which would be subtraction.**
- **Solve the following problem: 100 ÷ 2(10 + 15).**
    - **The first step is to do the operation in parentheses.**
        - **10 + 15 equals 25.**
    - **This makes the problem now 100 ÷ 2(25).**
    - **The next step is multiplication.**
        - **2(25) is shorthand for 2 X 25. That equals 50.**
    - **This makes the problem 100 ÷ 50.**
    - **The last step is division.**
        - **100 ÷ 50 equals 2.**

## Multiplying and Dividing Negative Numbers

- **Whenever you multiply (or divide) one number that is positive and another number that is negative, the result will be a negative number.**
- **Whenever you multiply (or divide) one number that is negative and another number that is negative, the result will be a *positive* number.**
- **Solve the following problem: (19 – (-10)) + 13 – (-4 – (-5)).**
    - **With regard to (19 – (-10)), there is a 1 in front of the (-10), so it becomes (-1) X (-10) which is equal to positive 10.**
    - **The problem is now (19 + 10) + 13 – (-4 – (-5)).**
    - **With regard to (-4 – (-5)), there is a 1 in front of the (-5), so it becomes (-1) X (-5) which is equal to positive 5.**
    - **The problem is now (19 + 10) + 13 – (-4 + 5).**
    - **Solving the terms in parentheses makes the problem 29 + 13 (1).**
    - **With regard to '– (1)', there is a 1 in front of the (1), therefore we have (-1) X (1) which is equal to -1.**
    - **The problem is now 29 + 13 – 1 which is equal to 42 – 1 which gives us our final answer of 41.**

**Helpful Links:**

**https://www.mathsisfun.com/geometry/protractor-using.html**

**http://www.mathsisfun.com/rounding-numbers.html**