Introduction

Earth Science employs the scientific method via qualitative and quantitative observation, the collection of data, hypothesis formulation/testing, and hypothesis modification. This lab exercise provides a basic introduction to quantitative observation and analysis.

Part 1 - Unit Conversion

Using the attached metric and English measurement unit conversion tables, complete the following conversions. SHOW ALL OF YOUR MATH WORK IN THE SPACE PROVIDED.

\[
\begin{align*}
2.05 \text{ m} &= 2 \times 10^5 \text{ cm} \quad 2.05 \text{ m} \left( \frac{100 \text{ cm}}{1 \text{ m}} \right) = 205 \text{ cm} \\
1.50 \text{ m} &= 1500 \text{ mm} \quad 1.50 \text{ m} \left( \frac{1500 \text{ mm}}{1 \text{ m}} \right) = 1500 \text{ mm} \\
5.4 \text{ g} &= 5400 \text{ mg} \\
6.8 \text{ m} &= 0.0068 \text{ km} \\
4214.6 \text{ cm} &= 42.15 \text{ m} \\
321.5 \text{ g} &= 0.3215 \text{ kg} \\
1 \text{ in} &= 2.54 \text{ cm} \\
1 \text{ m} &= 3.28 \text{ ft} \\
1 \text{ mi} &= 1.61 \text{ km} \\
123.4 \text{ mi} &= 199 \text{ km} \\
1234 \text{ km} &= 1234 \text{ mi} \\
1054 \text{ lb} &= 479 \text{ kg}
\end{align*}
\]

\[
\begin{align*}
2 \times 10^5 \text{ in} &= 3.17 \text{ mi} \left( \frac{2 \times 10^5 \text{ in}}{1 \text{ mi}} \right) = 63,360 \text{ in} \\
2 \times 10^8 \text{ ft} &= 3.8 \times 10^5 \text{ mi} \left( \frac{2 \times 10^8 \text{ ft}}{1 \text{ mi}} \right) = 5280 \text{ ft} \\
126,765,000 \text{ ft} &= 126,765,000 \left( \frac{1 \text{ mi}}{5280 \text{ ft}} \right) = 38,636.1 \text{ mi} \\
72^\circ \text{C} &= 161.6^\circ \text{F} \\
\left( \frac{9}{5} \right) \left( 72^\circ \text{C} \right) + 32^\circ = 161.6^\circ \text{F} \\
8^\circ \text{F} &= -13.3^\circ \text{C} \\
\left( \frac{9}{5} \right) \left( 8^\circ \text{F} - 32^\circ \right) = -13.3^\circ \text{C} \\
0^\circ \text{C} &= 212^\circ \text{F} \\
212^\circ \text{F} &= 100^\circ \text{C} \\
5.7 \times 10^{26} \text{ sec} &= 1.81 \times 10^{26} \text{ years} \\
5.7 \times 10^{45} \text{ sec} \left( \frac{1 \text{ yr}}{3.15 \times 10^7 \text{ sec}} \right) = 1.81 \times 10^{38} \text{ yr} \\
9.8 \times 10^{20} \text{ days} &= 2.68 \times 10^{18} \text{ years} \\
9.8 \times 10^{20} \text{ day} \left( \frac{1 \text{ yr}}{365.25 \text{ day}} \right) = 2.68 \times 10^8 \text{ yr} \\
2.0 \times 10^{31} \text{ mi} \left( \frac{1 \text{ km}}{3.9370 \text{ mi}} \right) = 5.1 \times 10^{26} \text{ km} \\
\text{If 1 inch equals 2000 ft on a map; points A and B are 7.8 inches apart on the map. How far apart are points A and B on the ground in feet? Now how about in miles?} \\
(7.8 \text{ in}) \left( \frac{2000 \text{ ft}}{1 \text{ in}} \right) = 15,600 \text{ ft} \\
15,600 \text{ ft} \left( \frac{1 \text{ mi}}{5280 \text{ ft}} \right) = 2.95 \text{ mi}
\end{align*}
\]
Part 2. Solving Equations

A. The density of a substance is defined by its mass divided by its volume. The equation has the following form:

\[ D = \frac{M}{V} \]

where \( D \) is density in \( \text{gm/cm}^3 \), \( M \) = mass in grams, and \( V \) is volume in \( \text{cm}^3 \)

1. You measure the mass of a substance as 2356 gm. Its volume is 534 cm\(^3\), calculate its density in \( \text{gm/cm}^3 \). SHOW THE FORMULA AND ALL OF YOUR MATH WORK!

\[ D = \frac{2356 \text{ gm}}{534 \text{ cm}^3} = 4.41 \text{ gm/cm}^3 \]

2. The density of a substance is 9.8 \( \text{gm/cm}^3 \). If you had a volume of 3.8 \( \text{cm}^3 \) of the substance, what would be the corresponding mass in grams? Hint: Rearrange the density equation to solve for mass. SHOW THE FORMULA AND ALL OF YOUR MATH WORK!

\[ \frac{V}{D} = \frac{m}{D} \implies D \cdot V = m \implies \left( 9.8 \frac{\text{gm}}{\text{cm}^3} \right) (3.8 \text{ cm}^3) = 37.24 \text{ gm} \]

3. The density of a substance is 2.5 \( \text{gm/cm}^3 \) and you possess 15.3 grams of that material. What will be its corresponding volume in \( \text{cm}^3 \)? Hint: Rearrange the density equation to solve for mass. SHOW THE FORMULA AND ALL OF YOUR MATH WORK!

\[ \frac{V}{D} = \frac{m}{D} \implies \frac{V}{D} = \frac{15.3 \text{ gm}}{2.5 \text{ gm/cm}^3} \implies 6.12 \text{ cm}^3 \]

B. The velocity of moving objects (for example your car while driving) is measured as a rate of motion, according to the following equation:

\[ V = \frac{d}{t} \]

where \( V \) is velocity (m/sec), \( d \) is distance (m), and \( t \) is time (sec).

4. You drive your car between two cities that are 123 miles apart. It takes you 4 hours to get there. Calculate your average velocity in m/hr. SHOW THE FORMULA AND ALL OF YOUR MATH WORK!

\[ V = \frac{d}{t} = \frac{123 \text{ mi}}{4 \text{ hr}} = 30.75 \text{ m/hr} \]

5. Using the velocity you calculated in 4 above, what was your velocity in m/sec? Hint: you will have to use a distance and time conversion factor. SHOW THE FORMULA AND ALL OF YOUR MATH WORK!

\[ \left( 30.75 \frac{\text{m}}{\text{hr}} \right) \left( \frac{1 \text{ hr}}{60 \text{ min}} \right) \left( \frac{1 \text{ min}}{60 \text{ sec}} \right) \left( \frac{1.61 \times 10^3 \text{ m}}{1 \text{ mi}} \right) = 13.28 \text{ m/sec} \]

6. You are driving a car at a velocity of 10 m/sec for a distance of 12 km. How long did it take you to get there? Answer in hours. SHOW THE FORMULA AND ALL OF YOUR MATH WORK!

\[ t = \frac{d}{V} = \frac{d}{V} \implies t = \frac{12 \text{ km}}{10 \text{ m/sec}} \cdot \frac{1000 \text{ m/km}}{1 \text{ m/sec}} = \frac{1200 \text{ m}}{2 \left( 10 \text{ m/sec} \right) \left( 3600 \text{ sec/hr} \right) \left( 1000 \text{ m/hr} \right)} = 0.03 \text{ hr} \]