MAR 110 Homework 1

Metric - English Conversion
[based on the Chauffe & Jefferies (2007)]

1-1. THE METRIC SYSTEM

The French developed the metric system during the 1790s. Unlike the "English" system, in which the difference between smaller and larger units is irregular and has no scientific foundation, the metric system is based on multiples of 10. Smaller and larger units can be obtained simply by moving the decimal point that is multiplying or dividing by 10. For example, in the "English" system there are 12 inches to a foot (ft), but 3 ft to a yard, and 1760 yards in a mile. By contrast, in the metric system there are 10 m to a decameter (dm), 10 dm to a hectometer (hm), and 10 hm to a kilometer (km). The convenience and regularity of the metric system make it the standard system used in scientific research.

The basic units of the metric system are the meter for length, gram for mass (weight), liter for volume, and degree Celsius (°C) for temperature. These terms have been defined in terms of practical considerations. For example, one meter is equal to one ten millionth of the distance between the North Pole and the equator. The gram is the mass of one cubic centimeter (or one millionth of a cubic meter) of water at a temperature of 4°C. The liter is the volume of a cubic decimeter (or one thousandth of a cubic meter). A degree Celsius is one-hundredth of the change in temperature between the freezing and boiling points of water. The French also experimented with decimal time, developing two types of clocks, one with 10 hours in a day and the other with one 100 hours in a day, but neither was widely accepted and both were eventually abandoned. Thus the metric and English systems use the same divisions of time and angles.

Because all parts of the metric system use the same prefixes to indicate size, it is useful to learn them and their meanings (see Table 1). Some of these terms will be familiar to you because they are used to describe the size of computer memory. They are kilobyte (1000 bytes), megabyte (1 million bytes) and gigabyte (1 billion bytes), or are parts of words.
with which you may be familiar, as in *kilowatts* (1000 watts), and in the names of insects, as in *millipede* (1000 legs) and *centipede* (100 legs).

**Table 1 Metric Prefixes and their Numerical Meanings**

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giga (G)</td>
<td>1,000,000,000</td>
</tr>
<tr>
<td>mega (M)</td>
<td>1,000,000</td>
</tr>
<tr>
<td>kilo (k)</td>
<td>1,000</td>
</tr>
<tr>
<td>hecto (h)</td>
<td>100</td>
</tr>
<tr>
<td>deka (da)</td>
<td>10</td>
</tr>
<tr>
<td>deci (d)</td>
<td>0.1</td>
</tr>
<tr>
<td>centi (c)</td>
<td>0.01</td>
</tr>
<tr>
<td>milli (m)</td>
<td>0.001</td>
</tr>
<tr>
<td>micro (µ)</td>
<td>0.000001</td>
</tr>
<tr>
<td>nano (n)</td>
<td>0.00000001</td>
</tr>
</tbody>
</table>

Until the U.S. adopts the metric system, as has most of the world and all branches of science, it will be necessary to learn how to convert units between the metric and English systems.

Conversion factors are provided in a chart at the end of this laboratory. When converting between the English and metric systems, it is important to keep track of the units.

The examples below show the procedure for using the conversion factor method to convert units for a few different cases. See conversion factors on pages ...

**Example 1. Convert 15.7 miles into kilometers** (Note the abbreviations used below).

a. From the conversion charts, we find that: 1 mi = 1.609 km.

b. We start with miles, but want to end with kilometers:

c. Thus you multiply 15.7 mi x 1.609 km/1 mi

d. Canceling out miles (mi), you multiply 15.7 x 1.609 km = **25.26 km**

**Example 2. Convert 8.54 miles into centimeters**.

From Example 1, we know that to convert miles to kilometers we multiply the number of miles by the factor 1.609 km / mi. The conversion from kilometers to centimeters is similar as follows.
a. From the conversion chart, we also find that: 1 km = 1000 m AND 1 m = 100 cm.

b. First convert 8.54 miles into kilometers as in Example 1 (canceling out the miles)

\[ 8.54 \text{ mi} \times \frac{1.609 \text{ km}}{1 \text{ mi}} = 13.74086 \text{ km} \]

c. Now convert 13.74086 km to meters, using the conversion factor 1 km = 1000 m

\[ 13.74086 \text{ km} \times \frac{1000 \text{ m}}{1 \text{ km}} = 13,740.86 \text{ m} \]

[note placement of conversion factor to cancel out the km]

d. Finally, convert 13,740.86 m to centimeters, using the conversion factor 1 m = 100 cm

\[ 13,740.86 \text{ m} \times \frac{100 \text{ cm}}{1 \text{ m}} = 1,374,086 \text{ cm} \]

[note placement of conversion factor to cancel out the meters]

e. If you want, you can do all three operations at once, as long as you keep track of the units so that they cancel out and give you what you want in the end.

\[ 8.54 \text{ mi} \times \frac{1.609 \text{ km}}{1 \text{ mi}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{100 \text{ cm}}{1 \text{ m}} = 1,374,086 \text{ cm}. \]

**Example 3. Convert 16 kilometers into inches.**

a. From the conversion charts we know: 1 km = 0.6214 mi

\[ 1 \text{ mi} = 5280 \text{ ft} \]

\[ 1 \text{ ft} = 12 \text{ in.} \]

b. First convert 16 kilometers to miles:

\[ 16 \text{ km} \times 0.6214 \text{ mi/km} = 9.9424 \text{ mi} \]

c. Now convert 9.9424 miles to feet:

\[ 9.9424 \text{ mi} \times 5280 \text{ ft/1 mi} = 52,398.72 \text{ ft} \]

d. Finally, convert 52,398.72 feet to inches:

\[ 52,398.72 \text{ ft} \times 12 \text{ in/ft} = 628,784.64 \text{ in} \]

e. Or you can do it all at once, if you are catching on!

\[ 16 \text{ km} \times 0.6214 \text{ mi/km} \times 5280 \text{ ft/mi} \times 12 \text{ in/ft} = 628,784.64 \text{ in} \]
Example 4. Convert 1.245 cubic feet (ft³) into liters (L).

a. From the convert chart we know: 1 ft³ = 1728 in³ 1 in³ = 16.39 cm³ 1 cm³ = 1 ml and 1 L = 1000 ml

b. This time, we are going to do all the operations at once. But you can do them one at a time, if you wish.

\[
1.245 \text{ ft³} \times \frac{1728 \text{ in³}}{\text{ft³}} \times \frac{16.39 \text{ cm³}}{\text{in³}} \times \frac{1 \text{ ml}}{\text{cm³}} \times \frac{1 \text{ L}}{1000 \text{ ml}} = 35.26 \text{ L.}
\]

Remember

The conversion factor method is easy, as long as you always multiply by the factor that will allow you to cancel out units, so that you end up with the unit(s) you want in your answer.

You must ALWAYS include the units.
No naked numbers!

“Units are your friends”
EXERCISE 1. CONVERSION OF UNITS

Convert each of the following quantities into those with the units that are requested. 
SHOW YOUR WORK!

a. Earth's circumference: 24,900 mi _______________ km ________________ m

b. Equatorial diameter: 12,756 km ______________ mi __________________ mi.

c. Ocean depth of 36,198 ft _________________ m ________________ km.

d. Highest point on Earth: 8847 m ________________ km ______________ ft
e. Wind speed of 30 mi/h ___________________ m/hr __________________ km/hr

f. Density of 60 lbs/ft^3 kg/m^3 __________ g/cm^3

g. Speed of Earth's equatorial rotation: 460 m/sec mi/hr __________ km/hr

h. Discharge of the Mississippi River: 61,000 ft^3/sec m^3/sec ___________ L/sec

i. An area of 2500mi^2 km^2 ______________ m^2
j. Mean density of the Earth: 5.522 g/cm$^3$ lbs/ft$^3$ ________________ kg/m$^3$

k. A 10 L container Gal ________________ in$^3$

l. A 55 gallon drum of oil ft$^3$ ________________ liters