Activity 2 – Dimensional Analysis Worksheet

Name  
Section  
Date

Exercise – Measured and Exact Numbers

Look at the commercial products in lab or at your home and create conversion factors (ratios) for fluid ounces to liters or milliliters. To do this, read the amounts present in both English units (fluid ounces, pints, quarts, pounds, ounces, etc.) and metric units (milliliters, liters, grams, kilograms, etc.) and then divide one value by the other, keeping the units.

<table>
<thead>
<tr>
<th>Product</th>
<th>English Measurement</th>
<th>Metric Measurement</th>
<th>Conversion Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coca Cola</td>
<td>12 oz</td>
<td>355 mL</td>
<td>$\frac{355 \text{ mL}}{12 \text{ oz}}$ or $\frac{12 \text{ oz}}{355 \text{ mL}}$</td>
</tr>
</tbody>
</table>

Many Possible Answers
Questions and Problems – Dimensional Analysis

For all of the following calculations, show all your work. If you need more space than is provided, you may do your work on separate pages but they must be attached. At least write your correct answers in the space provided. If you only provide the answers without showing your work somewhere you will not be given full credit. All answers should be clearly identified (boxed off), written in scientific notation if they are less than 1 or greater than 1000, and all should have the correct number of significant figures.

1. How many seconds are in exactly one day to five significant figures?

\[
\text{Road map: day } \rightarrow \text{ hour } \rightarrow \text{ min } \rightarrow \text{ sec} \\
1 \text{ day} \times \frac{24 \text{ hr}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 86400 \text{ sec} = 8.64 \times 10^4 \text{ sec}
\]

2. During surgery a patient receives 5.0 pts of plasma. (1 quart = 2 pints, 1 liter = 1.057 qt)

   a. How many milliliters of plasma were given?

\[
\text{Road map: pt } \rightarrow \text{ qt } \rightarrow \text{ L } \rightarrow \text{ mL} \\
5.0 \text{ pt} \times \frac{1 \text{ qt}}{2 \text{ pt}} \times \frac{1 \text{ L}}{1 \text{ qt}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 2365.184484 \text{ mL} = 2400 \text{ mL or } 2.4 \times 10^3 \text{ mL}
\]

   b. How many dL were given?

\[
\text{Road map: pt } \rightarrow \text{ qt } \rightarrow \text{ L } \rightarrow \text{ dL} \\
5.0 \text{ pt} \times \frac{1 \text{ qt}}{2 \text{ pt}} \times \frac{1 \text{ L}}{1 \text{ qt}} \times \frac{10 \text{ dL}}{1 \text{ L}} = 2365.184484 \text{ dL} = 240 \text{ dL}
\]

3. How many cubic meters of soil is needed to fill a flower box that is 3.5 feet long, 8 inches wide and 1 foot deep?

\[
\text{Sod: convert each to } \text{ m} \text{ and then multiply to get } \text{ m}^3. \text{ Road map: ft } \rightarrow \text{ in } \rightarrow \text{ cm } \rightarrow \text{ m} \\
3.5 \text{ ft} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{1 \text{ m}}{100 \text{ cm}} = 1.0668 \text{ m} \text{ Vol = L x W x H} \\
8 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{1 \text{ m}}{100 \text{ cm}} = 0.2032 \text{ m} \\
1 \text{ ft} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{1 \text{ m}}{100 \text{ cm}} = 0.3048 \text{ m} \text{ = 0.0464682642048 m} \\
= 0.07 \text{ m}
\]

4. Body temperatures above 41.1°C can lead to convulsions, especially in children.

   a. What is this temperature in °F?

\[
\text{°C} \times \frac{9}{5} + 32 = \text{°F} \\
41.1 \text{ °C} \times \frac{9}{5} + 32 = 105.98 \text{ °F} = 106 \text{ °F}
\]

   b. What is this temperature in K?

\[
\text{°C} + 273.15 = \text{K} \\
41.1 + 273.15 = 314.2 \text{ K}
\]

5. The mass of a premature baby is usually given in units of grams. If a baby weighs 1550 g, what is the mass in pounds?

\[
\text{Road map: g } \rightarrow \text{ lbs} \\
1550 \text{ g} \times \frac{1 \text{ lb}}{453.6 \text{ g}} = \frac{3.4171073837716}{16} = 3.42 \text{ lbs}
\]

6. An IV pump delivers medication at a constant rate of 24 mg/hr. How long does it take to deliver 9.0 x 10^7 mg?

\[
\text{Road map: mg } \rightarrow \text{ hr} \\
9.0 \times 10^7 \text{ mg} \times \frac{1 \text{ hr}}{24 \text{ mg}} = 3.75 \text{ hr} = 3.8 \text{ hr}
\]
7. The volume of blood plasma in adults is 3.1 L. The density of blood plasma is 1.03 g/cc. How many pounds of blood plasma are there in the average adult body? (Hint: You can use the density as a conversion factor once you convert the units of volume.)

\[
\text{Road Map: } 1 \text{ L} \rightarrow 1000 \text{ mL} \rightarrow 1 \text{ cc} \rightarrow 1.03 \text{ g} \rightarrow 1 \text{ lbs} \\
3.1 \text{ L} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{1 \text{ cc}}{1 \text{ mL}} \times \frac{1.03 \text{ g}}{1 \text{ cc}} \times \frac{1 \text{ lbs}}{453.6 \text{ g}} = 7.018 \text{ lbs} \\
\]

8. Which is the higher temperature, 18 °F or -1.0 °C?

\[-1.0 \text{ °C} \times \frac{180}{100} + 32 = 30.2 \text{ °F vs } 18 \text{ °F} \]

\[\text{°C to °F Conversion Factor: } 1 \text{ °C} = 1.8 \text{ °F} + 32, \text{ or } 1 \text{ °C} = \frac{9}{5} \text{ °F} + 32 \]

\[-1.0 \text{ °C is higher than } 18 \text{ °F} \]

9. The air is 78% nitrogen.

c. Can you find the conversion factor in the percentage of nitrogen?

\[\frac{48 \text{ g N}_2}{100 \text{ g Air}} \quad \text{or} \quad \frac{48 \text{ kg N}_2}{100 \text{ kg Air}} \]

d. If you have a sample of air that weighs 1.25 kg, how many kg of nitrogen are present?

\[\text{Road Map: } 1 \text{ kg Air} \rightarrow 1 \text{ kg N}_2 \]

\[1.25 \text{ kg Air} \times \frac{48 \text{ kg N}_2}{100 \text{ kg Air}} = 0.975 \text{ kg N}_2 \]

10. The accepted toxic dose of mercury is 300 mg/day. Dental offices sometimes contain as much as 180 mg per cubic meter of air. If a dental hygienist working in the office ingests 2 \times 10^4 \text{ L of air per day, is he or she at risk for mercury poisoning? (Hint: Start with the amount of air ingested. Remember, if 1 m = 100 cm, then 1 m}^3 = 100^3 \text{ cm}^3 = 1,000,000 \text{ cm}^3) } \]

\[\text{Road Map: } \frac{1 \text{ day}}{1 \text{ day}} \rightarrow \frac{1 \text{ m}^3 \text{ air}}{1 \text{ m}^3 \text{ air}} \rightarrow \frac{180 \text{ mg Hg}}{1 \text{ m}^3 \text{ air}} \rightarrow \frac{3600 \text{ mg Hg}}{1 \text{ day}} \rightarrow \frac{4000 \text{ mg Hg/day}}{1 \text{ day}} \]

11. Urine is a water-based solution containing a variety of dissolved solids. The specific gravity of a urine sample of a young wrestler is outside the normal range at 1.045.

e. What is the density of the urine sample? (for pure water \(d_{25} = 1.00 \text{ g/mL}\))

\[\text{density}_{\text{mass}} = \frac{1.00 \text{ g/mL}}{1 \text{ mL}} \rightarrow \text{density} = 1.00 \text{ g/mL} \]

\[\text{density} \times 1.045 \times 1.00 \text{ g/mL} = 1.045 \text{ g/mL} \]

f. Is it more likely that the wrestler is dehydrated or that he recently drank a large amount of water? You will use words for this answer, no calculations necessary. (Hint: Review the definition of density)

\[\text{Density: } 1.00 \text{ g/mL} \rightarrow 1.010 \text{ g/mL} \rightarrow 1.030 \text{ g/mL} \rightarrow 1.045 \text{ g/mL} \]

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