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 be sure to attach these when you are done. Write your correct answers in the space provided. If you only provide the answers without showing your work, you will not be given full credit. All answers should be clearly identified (boxed off), written in scientific notation if the values 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?

Road map: day → hr → min → sec

$$1\ \text{day} \times \frac{24\ \text{hr}}{1\ \text{day}} \times \frac{60\ \text{min}}{1\ \text{hr}} \times \frac{60\ \text{sec}}{1\ \text{min}} = 86400\ \text{sec} = \boxed{86400.\ \text{sec}}$$

2. Seventeen apples weigh 3.25 pounds. They cost 59 cents for 1 pound. What is the cost of 8.95×10^3 apples?

Road Map: apples → lbs → ¢ → $

$$8.95 \times 10^3\ \text{apples} \times \frac{3.25\ \text{lbs}}{17\ \text{apples}} \times \frac{59\ ¢}{1\ \text{lbs}} \times \frac{\$1}{100\ ¢} = \$1009.507353 = \boxed{\$1.0 \times 10^3}$$

3. The distance from Santa Cruz to Santa Barbara is about 280 miles. If a car gets 23.6 miles per gallon, and the price of gas is 32 cents per liter, how much will it cost for gas to drive from Santa Cruz to Santa Barbara?

Road Map: miles → gal → L → ¢ → $

$$280\ \text{mi} \times \frac{1\ \text{gal}}{23.6\ \text{mi}} \times \frac{3.785\ \text{L}}{1\ \text{gal}} \times \frac{32\ ¢}{1\ \text{L}} \times \frac{\$1}{100\ ¢} = \$14.370169\ldots = \boxed{\$14}$$

4. It is found that 5 pears weigh an average of 1.9 pounds. A box of pears cost $7.94. The price per pound is 55 cents. How many pears are in exactly 7 boxes?

Road Map: boxes → $ → ¢ → lbs → pears

$$\text{Exact}\ 7\ \text{boxes} \times \frac{\$7.94}{1\ \text{box}} \times \frac{100\ ¢}{\$1} \times \frac{1\ \text{lbs}}{55\ ¢} \times \frac{5\ \text{pears}}{1.9\ \text{lbs}} = 265.933\ldots\ \text{pears} = \boxed{270\ \text{pears}}$$

5. 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?

Road Map: pts → qt → L → mL

$$5.0\ \text{pts} \times \frac{1\ \text{qt}}{2\ \text{pts}} \times \frac{1\ \text{L}}{1.057\ \text{qt}} \times \frac{1000\ \text{mL}}{1\ \text{L}} = 2365.184485\ \text{mL} = \boxed{2400\ \text{mL}}$$

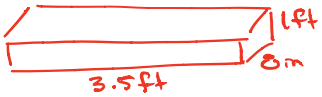
   b. How many dL were given?

Road map: pts → qt → L → dL

$$5.0\ \text{pts} \times \frac{1\ \text{qt}}{2\ \text{pts}} \times \frac{1\ \text{L}}{1.057\ \text{qt}} \times \frac{10\ \text{dL}}{1\ \text{L}} = 23.65184485\ \text{dL} = \boxed{24\ \text{dL}}$$

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

Road Map $ft \rightarrow in \rightarrow cm \rightarrow m \rightarrow m^3$ or $in^3 \rightarrow cm^3 \rightarrow m^3$



$3.5\,ft \times \frac{12\,in}{1\,ft} = 42\,in$

$42\,in \times 8\,in \times 12\,in = 4032\,in^3$ (1 SF)

$4032\,in^3 \times \frac{2.54^3\,cm^3}{1\,in^3} \times \frac{1\,m^3}{100^3\,cm^3} = 0.066607\,m^3 = \boxed{0.07\,m^3}$

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

a. What is this temperature in °F?

°C → °F $\quad °C \times \frac{180°F}{100°C} + 32° = °F$

$41.1°C \times \frac{180°F}{100°C} + 32° = 105.98°F = \boxed{106°F}$ (Exact)

b. What is this temperature in K?

°C → K $\quad °C + 273.15 = K$

$41.1°C + 273.15 = 314.25\,K$

$\boxed{314.2\,K}$ Round Even rule

8. The daily dose of ampicillin for the treatment of an ear infection is 115 mg ampicillin per kg of body weight. The pill is dispensed in 500. mg tablets. How many tablets should be given daily for a 75 pound child? ~~An IV pump delivers medication at a constant rate of 24 mg/hr. How long does it take to deliver 9.0×10^1 mg?~~ drop this part. Typo

Road Map lbs body → g body → kg body → mg amp → pills or tablets

$75\,lbs\,body \times \frac{453.6\,g\,body}{1\,lbs\,body} \times \frac{1\,kg\,body}{1000\,g\,body} \times \frac{115\,mg\,amp}{1\,kg\,body} \times \frac{1\,pill}{500.\,mg\,amp} = 7.8246\,pills$

$\boxed{7.8\,pills}$

9. 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.)

Road Map L plasma → mL plasma → cc plasma → g plasma → lbs plasma

$3.1\,L \times \frac{1000\,mL}{1\,L} \times \frac{1\,cc}{1\,mL} \times \frac{1.03\,g}{1\,cc} \times \frac{1\,lbs}{453.6\,g} = 7.0392416\,lbs$

$\boxed{7.0\,lbs\,plasma}$

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

Convert °F to °C or other way & Compare

$(18°F - 32°F) \times \frac{100°C}{180°F} = -7.777°C = -7.8°C$

or

$\boxed{-1.0°C}$

Higher

11. A bottle of Cabernet Sauvignon is labeled as having an alcohol content of 12.5% by volume.

    a. Write the percentage of the alcohol in the wine as a conversion factor.

$$\frac{12.5\ \text{mL alcohol}}{100\ \text{mL wine}}$$

    b. If an individual were to consume 320. mL of the wine, how many fluid ounces of pure alcohol would the individual have ingested? (1 pint = 16 ounces; 8 pints = 1 gal)

Road Map: mL wine → mL alcohol → L → gal → pts → oz

$$320.\ \text{mL wine} \times \frac{12.5\ \text{mL alcohol}}{100\ \text{mL wine}} \times \frac{1\ \text{L}}{1000\ \text{mL}} \times \frac{1\ \text{gal}}{3.785\ \text{L}} \times \frac{8\ \text{pts}}{1\ \text{gal}} \times \frac{16\ \text{oz}}{1\ \text{pts}}$$

$$= 1.352708\ \text{oz} = \boxed{1.35\ \text{oz}}$$

12. Urine is a water-based solution containing a variety of dissolved solids. The specific gravity of a urine sample of a young wrestler is 1.045, which is outside the normal range of 1.003 – 1.030. (The specific gravity of a substance is its density divided by the density of water at 4°C, at which the assumption stated below is accurate.)

    a. What is the density (d) of the urine sample? (Assume that d(H_2O) = 1.00 g/mL)

$$\text{Specific gravity} = \frac{\text{density}}{\text{density } H_2O} \quad \therefore \text{density} = \text{specific gravity} \times \text{density } H_2O$$

$$1.045 \times 1.000\ \text{g/mL} = \boxed{1.045\ \text{g/mL}}$$

    b. 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)

hydrated ⟵ 1.003 g/mL ... 1.030 g/mL < 1.045 g/mL ⟵ dehydrated

Wrestler is dehydrated