General Physics I
Homework Chapter 1

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Homework: Chapter 1

Problem (1)

The micrometer (1 μm) is often called the *micron*.

Question (a)

How many microns make up 3.7 km?
R:

$$\begin{aligned} 3.7\ km &= ?\ \mu m \\ &= 3.7\ km \times \left(\frac{10^3\ m}{1\ km}\right) \times \left(\frac{10^6\ \mu m}{1\ m}\right) \\ &= 3.7 \times 10^9\ \mu m = 3\ 700\ 000\ 000\ \mu m \end{aligned} \tag{1}$$

Question (b)

How many centimeters equal 3.7 μm?
R:

$$\begin{aligned} 3.7\ cm &= ?\ \mu m \\ &= 3.7\ cm \times \left(\frac{10\ mm}{1\ cm}\right) \times \left(\frac{10^3\ \mu m}{1\ mm}\right) \\ &= 3.7 \times 10^4\ \mu m = 37\ 000\ \mu m \end{aligned} \tag{2}$$

Question (c)

How many microns are in 3.7 yd?
R:

$$
\begin{aligned}
3.7\ yd &= ?\ \mu m \\
&= 3.7\ yd \times \left(\frac{3\ ft}{1\ yd}\right) \times \left(\frac{12\ in}{1\ ft}\right) \times \left(\frac{2.54\ cm}{1\ in}\right) \times \left(\frac{10^4\ \mu m}{1\ cm}\right) \\
&= 3.38328 \times 10^6\ \mu m = 3\ 383\ 280\ \mu m
\end{aligned} \tag{3}
$$

Problem (2)

Hydraulic engineers in the United States often use, as a units of volume of water, the acre-foot, defined as the volume of water that will cover 1 $acre$ (where 1 $acre = 43560\ ft^2$) of land to a depth of 1 ft. A severe thunderstorm dumped 2.5 $in.$ of rain in 30 min on a town of area 36 km^2. What volume of water, in acre-feet, fell on the town?
R:
Step 1: Convert 2.5 $in. \rightarrow ft$

$$
\begin{aligned}
2.5\ in. &= ?\ ft \\
&= 2.5\ in. \times \left(\frac{1\ ft}{12\ in.}\right) \\
&= 2.083 \times 10^{-1}\ ft = 0.2083\ ft
\end{aligned} \tag{4}
$$

Step 2: Convert 36 $km^2 \rightarrow acres$

$$
\begin{aligned}
36\ km &= ?\ acres \\
&= 36\ km^2 \times \left(\frac{10^5\ cm}{1\ km}\right)^2 \times \left(\frac{1\ in.}{2.54\ cm}\right)^2 \times \left(\frac{1\ ft}{12\ in.}\right)^2 \times \left(\frac{1\ acre}{43560\ ft^2}\right) \\
&= 8.8958 \times 10^3\ acres = 8\ 895.8\ acres
\end{aligned} \tag{5}
$$

Step 3: Discover the volume in acre-feet using eq. (5) and eq. (4)

$$
\begin{aligned}
\left(8.8958 \times 10^3\right)\ acres \times \left(2.083 \times 10^{-1}\right)\ ft &= 1.853 \times 10^3\ acre \times ft \\
&= 1853\ acre \times ft
\end{aligned} \tag{6}
$$

Problem (3)

The fastest growing plant on record is the *Hesperoyucca whipplei*. Suppose a plant of this type can grow 2.5 m in 12 days. What is this growth rate in micrometers per seconds?
R:
Step 1: Discover the growth rate in meters per day

$$\begin{aligned} \frac{2.5\ m}{12\ \text{days}} &= 2.0833 \times 10^{-1}\ m/\text{day} \\ &= 0.20833\ m/\text{day} \end{aligned} \tag{7}$$

Step 2: Discover how many seconds are in one day

$$\begin{aligned} 1\ \text{day} &= ?\ s \\ &= 1\ \text{day} \times \left(\frac{24\ h}{1\ \text{day}}\right) \times \left(\frac{60\ min}{1\ h}\right) \times \left(\frac{60\ s}{1\ min}\right) \\ &= 8.64 \times 10^4\ s = 86400\ s \end{aligned} \tag{8}$$

Step 3: Convert eq. (7) $\rightarrow \mu m/s$

$$\begin{aligned} 2.0833 \times 10^{-1}\ m/\text{day} &= ?\ \mu m/s \\ &= 2.0833 \times 10^{-1}\ m/\text{day} \times \left(\frac{10^6\ \mu m}{1\ m}\right) \times \left(\frac{1\ \text{day}}{8.64 \times 10^4\ s}\right) \\ &= 2.4112\ \mu m/s \end{aligned} \tag{9}$$

Problem (4)

A fortnight is a charming English measure of time equal to 2.0 weeks (the word is a contraction of " fourteen nights "). That is a nice amount of time in pleasant company but perhaps a painful string of microseconds in unpleasant company. How many microseconds are in 5.0 fortnights?

R:

$$
\begin{aligned}
5.0 \text{ fortnights} &= ?\ \mu s \\
&= 5.0 \text{ fortnights} \times \left(\frac{2 \text{ weeks}}{1 \text{ fortnight}}\right) \times \left(\frac{7 \text{ days}}{1 \text{ week}}\right) \\
&\quad \times \left(\frac{8.64 \times 10^4\ s}{1 \text{ day}}\right) \times \left(\frac{10^6\ \mu s}{1\ s}\right) \\
&\approx 6.0 \times 10^{12}\ \mu s && (10) \\
&\quad (\text{Exact Value} : 6\ 048\ 000\ 000\ 000\ \mu s) && (11)
\end{aligned}
$$

Problem (5)

For about 10 years after the French Revolution, the French government attempted to base measures of time on multiples of ten: One week consisted of 10 days, one day consisted of 10 hours, one hour consisted of 100 minutes, and one minute consisted of 100 seconds. For the questions below, assume that the definition of a “ day ” remains the same. Note that a “ ratio ” is simply a single decimal value.

Question (a)

What are the ratio of the French decimal week to the standard week?
R:
Since a day in both standards are the same, the ratio can be discovered as follow:

$$
\begin{aligned}
1 \text{ French week} &= 10 \text{ days} && (12) \\
1 \text{ standard week} &= 7 \text{ days} && (13) \\
\frac{10 \text{ days}}{7 \text{ days}} &\approx 1.43 && (14)
\end{aligned}
$$

Question (b)

What are the ratio of the French decimal second to the standard second?
R:

Since a day in both standards are the same, the ratio can be discovered as follow:

$$\begin{aligned} 1 \text{ day} &= 10 \text{ French hours} \\ &= 10^3 \text{ French minutes} \\ &= 10^5 \text{ French seconds} && (15) \\ 1 \text{ day} &= 8.64 \times 10^4 \ s && (16) \\ \frac{10^5 \text{ French seconds}}{8.64 \times 10^4 \ s} &\approx 1.16 && (17) \end{aligned}$$

Problem (6)

Assuming that each cubic centimeter of water has a mass of exactly 1 g

Question (a)

Find the mass of 5.3 cubic meters of water in kg.
R:

$$\begin{aligned} 1 \ cm^3 &\equiv 1 \ g && (18) \\ 5.3 \ m^3 &= ? \ cm^3 \\ &= 5.3 \ m^3 \times \left(\frac{10^2 \ cm}{1 \ m}\right)^3 \\ &= 5.3 \times 10^6 \ cm^3 && (19) \\ 5.3 \times 10^6 \ cm^3 &\equiv 5.3 \times 10^6 \ g && (20) \\ 5.3 \times 10^6 \ g &= ? \ kg \\ &= 5.3 \times 10^6 \ g \times \left(\frac{1kg}{10^3 g}\right) \\ &= 5.3 \times 10^3 \ kg && (21) \\ 5.3 \ m^3 &\equiv 5\ 300 \ kg && (22) \end{aligned}$$

Question (b)

Suppose that it takes 13 hours to drain a container of $67m^3$ of water. What is the “ mass flow rate, ” in kg/s, of water from the container?

R:

$$\begin{aligned}
1\ m^3 &\equiv 10^3\ kg && (23)\\
67\ m^3 &\equiv 6.7\times 10^4\ kg && (24)\\
13\ h &= 13\times 8.64\times 10^4\ s \\
&= 1.1232\times 10^6\ s && (25)\\
\frac{6.7\times 10^4\ kg}{1.1232\times 10^6\ s} &\approx 5.9651\times 10^{-2}\ kg/s && (26)
\end{aligned}$$

Problem (7)

A cord is a volume of cut wood equal to a stack 8 ft long, 4 ft wide, and 4 ft high. How many cords are in $18m^3$?
R:

$$\begin{aligned}
1\ \text{cord} &= 8\ ft\ \times 4\ ft\ \times 4\ ft \\
&= 128\ ft^3 && (27)\\
128\ ft^3 &= ?\ m^3 \\
&= 128\ ft^3\times\left(\frac{12\ in.}{1\ ft}\right)^3\times\left(\frac{2.54\ cm}{1\ in.}\right)^3\times\left(\frac{1\ m}{100\ cm}\right)^3 \\
&\approx 3.625\ m^3 && (28)\\
\frac{18\ m^3}{3.625\ m^3(\approx 1\ \text{cord})} &\approx 4.966\ (\text{cords}) && (29)
\end{aligned}$$

Problem (8)

Using conversions and data in the chapter, determine the number of hydrogen atoms required to obtain 3.9 kg of hydrogen. A hydrogen atom has a mass of 1.0 u, where “ u ” stands for “ atomic mass unit ”.
R:

$$1.0\ u = 1.660\ 538\ 7 \times 10^{-27}\ kg \tag{30}$$

$$\frac{3.9\ kg}{1.660\ 538\ 7 \times 10^{-27}\ kg} = 2.348\ 635\ 4 \times 10^{27}\ \text{(hydrogen atoms)} \tag{31}$$