VOLUME 1.

PART 1.

PART 2.

VOLUME 2.

PART 3.

PART 4.

PART 5.

Chapter 1

1. Various geometric formulas are given in Appendix E.

(a) Expressing the radius of the Earth as

$$R = \left(6.37 \times 10^6 \text{ m}\right)\left(10^{-3} \text{ km/m}\right) = 6.37 \times 10^3 \text{ km},$$

its circumference is $s = 2\pi R = 2\pi(6.37 \times 10^3 \text{ km}) = 4.00 \times 10^4 \text{ km}$.

(b) The surface area of Earth is $A = 4\pi R^2 = 4\pi \left(6.37 \times 10^3 \text{ km}\right)^2 = 5.10 \times 10^8 \text{ km}^2$.

(c) The volume of Earth is $V = \frac{4\pi}{3} R^3 = \frac{4\pi}{3}\left(6.37 \times 10^3 \text{ km}\right)^3 = 1.08 \times 10^{12} \text{ km}^3$.

2. The conversion factors are: $1 \text{ gry} = 1/10 \text{ line}$, $1 \text{ line} = 1/12 \text{ inch}$ and 1 point = 1/72 inch. The factors imply that

1 gry = (1/10)(1/12)(72 points) = 0.60 point.

Thus, 1 gry^2 = (0.60 point)^2 = 0.36 point^2, which means that $0.50 \text{ gry}^2 = 0.18 \text{ point}^2$.

3. The metric prefixes (micro, pico, nano, …) are given for ready reference on the inside front cover of the textbook (see also Table 1–2).

(a) Since 1 km = 1 × 10^3 m and 1 m = 1 × 10^6 μm,

$$1 \text{km} = 10^3 \text{ m} = \left(10^3 \text{ m}\right)\left(10^6 \ \mu\text{m/m}\right) = 10^9 \ \mu\text{m}.$$

The given measurement is 1.0 km (two significant figures), which implies our result should be written as 1.0 × 10^9 μm.

(b) We calculate the number of microns in 1 centimeter. Since 1 cm = 10^{-2} m,

$$1 \text{cm} = 10^{-2} \text{ m} = \left(10^{-2} \text{m}\right)\left(10^6 \ \mu\text{m/m}\right) = 10^4 \ \mu\text{m}.$$

We conclude that the fraction of one centimeter equal to 1.0 μm is 1.0 × 10^{-4}.

(c) Since 1 yd = (3 ft)(0.3048 m/ft) = 0.9144 m,

$$1.0\,\text{yd} = (0.91\text{m})(10^6\ \mu\text{m/m}) = 9.1\times10^5\ \mu\text{m}.$$

4. (a) Using the conversion factors 1 inch = 2.54 cm exactly and 6 picas = 1 inch, we obtain

$$0.80\ \text{cm} = (0.80\ \text{cm})\left(\frac{1\ \text{inch}}{2.54\ \text{cm}}\right)\left(\frac{6\ \text{picas}}{1\ \text{inch}}\right) \approx 1.9\ \text{picas}.$$

(b) With 12 points = 1 pica, we have

$$0.80\ \text{cm} = (0.80\ \text{cm})\left(\frac{1\ \text{inch}}{2.54\ \text{cm}}\right)\left(\frac{6\ \text{picas}}{1\ \text{inch}}\right)\left(\frac{12\ \text{points}}{1\ \text{pica}}\right) \approx 23\ \text{points}.$$

5. Given that $1\ \text{furlong} = 201.168\ \text{m}$, $1\,\text{rod} = 5.0292\ \text{m}$ and $1\,\text{chain} = 20.117\ \text{m}$, we find the relevant conversion factors to be

$$1.0\ \text{furlong} = 201.168\ \text{m} = (201.168\ \cancel{\text{m}})\frac{1\ \text{rod}}{5.0292\ \cancel{\text{m}}} = 40\ \text{rods},$$

and

$$1.0\ \text{furlong} = 201.168\ \text{m} = (201.168\ \cancel{\text{m}})\frac{1\ \text{chain}}{20.117\ \cancel{\text{m}}} = 10\ \text{chains}.$$

Note the cancellation of m (meters), the unwanted unit. Using the given conversion factors, we find

(a) the distance *d in rods* to be

$$d = 4.0\ \text{furlongs} = (4.0\ \text{fu}\cancel{\text{r}}\text{longs})\frac{40\ \text{rods}}{1\ \text{fu}\cancel{\text{r}}\text{long}} = 160\ \text{rods},$$

(b) and that distance *in chains* to be

$$d = 4.0\ \text{furlongs} = (4.0\ \text{fu}\cancel{\text{r}}\text{longs})\frac{10\ \text{chains}}{1\ \text{fu}\cancel{\text{r}}\text{long}} = 40\ \text{chains}.$$

6. We make use of Table 1-6.

(a) We look at the first ("cahiz") column: 1 fanega is equivalent to what amount of cahiz? We note from the already completed part of the table that 1 cahiz equals a dozen fanega. Thus, 1 fanega = $\frac{1}{12}$ cahiz, or 8.33×10^{-2} cahiz. Similarly, "1 cahiz = 48 cuartilla" (in the already completed part) implies that 1 cuartilla = $\frac{1}{48}$ cahiz, or 2.08×10^{-2} cahiz. Continuing in this way, the remaining entries in the first column are 6.94×10^{-3} and 3.47×10^{-3}.

(b) In the second ("fanega") column, we find 0.250, 8.33×10^{-2}, and 4.17×10^{-2} for the last three entries.

(c) In the third ("cuartilla") column, we obtain 0.333 and 0.167 for the last two entries.

(d) Finally, in the fourth ("almude") column, we get $\frac{1}{2}$ = 0.500 for the last entry.

(e) Since the conversion table indicates that 1 almude is equivalent to 2 medios, our amount of 7.00 almudes must be equal to 14.0 medios.

(f) Using the value (1 almude = 6.94×10^{-3} cahiz) found in part (a), we conclude that 7.00 almudes is equivalent to 4.86×10^{-2} cahiz.

(g) Since each decimeter is 0.1 meter, then 55.501 cubic decimeters is equal to 0.055501 m^3 or 55501 cm^3. Thus, 7.00 almudes = $\frac{7.00}{12}$ fanega = $\frac{7.00}{12}$(55501 cm^3) = 3.24×10^4 cm^3.

7. We use the conversion factors found in Appendix D.

$$1 \text{ acre} \cdot \text{ft} = (43{,}560 \text{ ft}^2) \cdot \text{ft} = 43{,}560 \text{ ft}^3$$

Since 2 in. = (1/6) ft, the volume of water that fell during the storm is

$$V = (26 \text{ km}^2)(1/6 \text{ ft}) = (26 \text{ km}^2)(3281\text{ft/km})^2(1/6 \text{ ft}) = 4.66 \times 10^7 \text{ ft}^3.$$

Thus,

$$V = \frac{4.66 \times 10^7 \text{ ft}^3}{4.3560 \times 10^4 \text{ ft}^3 / \text{acre} \cdot \text{ft}} = 1.1 \times 10^3 \text{ acre} \cdot \text{ft}.$$

8. From Fig. 1-4, we see that 212 S is equivalent to 258 W and 212 – 32 = 180 S is equivalent to 216 – 60 = 156 Z. The information allows us to convert S to W or Z.

(a) In units of W, we have

$$50.0 \text{ S} = (50.0 \text{ S})\left(\frac{258 \text{ W}}{212 \text{ S}}\right) = 60.8 \text{ W}$$

(b) In units of Z, we have

$$50.0 \text{ S} = (50.0 \text{ S})\left(\frac{156 \text{ Z}}{180 \text{ S}}\right) = 43.3 \text{ Z}$$

9. The volume of ice is given by the product of the semicircular surface area and the thickness. The area of the semicircle is $A = \pi r^2/2$, where r is the radius. Therefore, the volume is

$$V = \frac{\pi}{2} r^2 z$$

where z is the ice thickness. Since there are 10^3 m in 1 km and 10^2 cm in 1 m, we have

$$r = (2000\,\text{km}) \left(\frac{10^3\,\text{m}}{1\,\text{km}}\right) \left(\frac{10^2\,\text{cm}}{1\,\text{m}}\right) = 2000 \times 10^5 \text{ cm}.$$

In these units, the thickness becomes

$$z = 3000\,\text{m} = (3000\,\text{m}) \left(\frac{10^2\,\text{cm}}{1\,\text{m}}\right) = 3000 \times 10^2 \text{ cm}$$

which yields $V = \frac{\pi}{2}\left(2000 \times 10^5 \text{ cm}\right)^2 \left(3000 \times 10^2\,\text{cm}\right) = 1.9 \times 10^{22} \text{ cm}^3$.

10. Since a change of longitude equal to $360°$ corresponds to a 24 hour change, then one expects to change longitude by $360°/24 = 15°$ before resetting one's watch by 1.0 h.

11. (a) Presuming that a French decimal day is equivalent to a regular day, then the ratio of weeks is simply 10/7 or (to 3 significant figures) 1.43.

(b) In a regular day, there are 86400 seconds, but in the French system described in the problem, there would be 10^5 seconds. The ratio is therefore 0.864.

12. A day is equivalent to 86400 seconds and a meter is equivalent to a million micrometers, so

$$\frac{(3.7\,\text{m})(10^6\,\mu\text{m/m})}{(14\,\text{day})(86400\,\text{s/day})} = 3.1\,\mu\text{m/s}.$$

13. The time on any of these clocks is a straight-line function of that on another, with slopes $\neq$ 1 and y-intercepts $\neq$ 0. From the data in the figure we deduce

$$t_C = \frac{2}{7}t_B + \frac{594}{7}, \quad t_B = \frac{33}{40}t_A - \frac{662}{5}.$$

These are used in obtaining the following results.

(a) We find

$$t'_B - t_B = \frac{33}{40}\left(t'_A - t_A\right) = 495 \text{ s}$$

when $t'_A - t_A = 600$ s.