6. We make use of Table 1-6.

(a)We look at the first (ñcahizò) 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, ñ1 cahiz = 48 cuartillaò (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 (ñfanegaò) column, we find 0.250, 8.33×10^{-2}, and 4.17×10^{-2} for the last three entries.

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

(d) Finally, in the fourth (ñalmudeò) 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.

14. The metric prefixes (micro (μ), pico, nano, é) are given for ready reference on the inside front cover of the textbook (also Table 1ï 2).

(a) $1\ \mu\text{century} = \left(10^{-6}\ \text{century}\right)\left(\dfrac{100\ \text{y}}{1\ \text{century}}\right)\left(\dfrac{365\ \text{day}}{1\ \text{y}}\right)\left(\dfrac{24\ \text{h}}{1\ \text{day}}\right)\left(\dfrac{60\ \text{min}}{1\ \text{h}}\right) = 52.6\ \text{min}.$

(b) The percent difference is therefore

$$\frac{52.6\ \text{min} - 50\ \text{min}}{52.6\ \text{min}} = 4.9\%.$$

16. We denote the pulsar rotation rate f (for frequency).

$$f = \frac{1 \text{ rotation}}{1.55780644887275 \times 10^{-3} \text{ s}}$$

(a) Multiplying f by the time-interval t = 8.00 days (which is equivalent to 691200 s, if we ignore *significant figure* considerations for a moment), we obtain the number of rotations:

$$N = \left(\frac{1 \text{ rotation}}{1.55780644887275 \times 10^{-3} \text{ s}}\right)(691200 \text{ s}) = 443700.8$$

which should now be rounded to 4.44×10^8 rotations since the time-interval was specified in the problem to three significant figures.

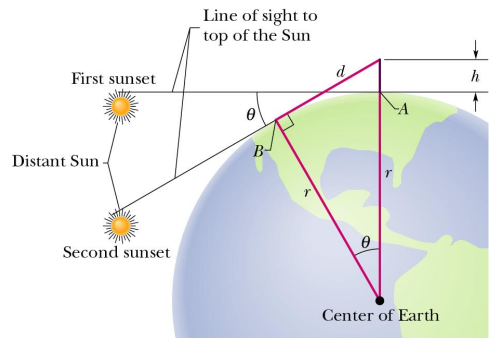
(b) We note that the problem specifies the *exact* number of pulsar revolutions (one million). In this case, our unknown is t, and an equation similar to the one we set up in part (a) takes the form $N = ft$, or

$$1 \times 10^6 = \left(\frac{1 \text{ rotation}}{1.55780644887275 \times 10^{-3} \text{ s}}\right) t$$

which yields the result t = 1557.80644887275 s (though students who do this calculation on their calculator might not obtain those last several digits).

(c) Careful reading of the problem shows that the time-uncertainty *per revolution* is $\pm 3 \times 10^{-17}$s . We therefore expect that as a result of one million revolutions, the uncertainty should be $(\pm 3 \times 10^{-17})(1 \times 10^6) = \pm 3 \times 10^{-11}$ s .

19. When the Sun first disappears while lying down, your line of sight to the top of the Sun is tangent to the Earthôs surface at point A shown in the figure. As you stand, elevating your eyes by a height h, the line of sight to the Sun is tangent to the Earthôs surface at point B.



Let d be the distance from point B to your eyes. From the Pythagorean theorem, we have

$$d^2 + r^2 = (r+h)^2 = r^2 + 2rh + h^2$$

or $d^2 = 2rh + h^2$, where r is the radius of the Earth. Since $r \gg h$, the second term can be dropped, leading to $d^2 \approx 2rh$. Now the angle between the two radii to the two tangent points A and B is θ, which is also the angle through which the Sun moves about Earth during the time interval t = 11.1 s. The value of θ can be obtained by using

$$\frac{\theta}{360°} = \frac{t}{24\ \text{h}}.$$

This yields

$$\theta = \frac{(360°)(11.1\ \text{s})}{(24\ \text{h})(60\ \text{min/h})(60\ \text{s/min})} = 0.04625°.$$

Using $d = r\tan\theta$, we have $d^2 = r^2\tan^2\theta = 2rh$, or

$$r = \frac{2h}{\tan^2\theta}$$

Using the above value for θ and h = 1.7 m, we have $r = 5.2\times10^6$ m.

22. The density of gold is

$$\rho = \frac{m}{V} = \frac{19.32\ \text{g}}{1\ \text{cm}^3} = 19.32\ \text{g/cm}^3.$$

(a) We take the volume of the leaf to be its area A multiplied by its thickness z. With density $\rho = 19.32\ \text{g/cm}^3$ and mass $m = 29.34$ g, the volume of the leaf is found to be

$$V = \frac{m}{\rho} = \frac{29.34\ \text{g}}{19.32\ \text{g/cm}^3} = 1.519\ \text{cm}^3.$$

We convert the volume to SI units:

$$V = \left(1.519\ \text{cm}^3\right)\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)^3 = 1.519\times 10^{-6}\ \text{m}^3$$

Since $V = Az$ with $z = 1.000\times 10^{-6}$ m (metric prefixes can be found in Table 1ï 2), we obtain

$$A = \frac{1.519\times 10^{-6}\,\text{m}^3}{1\times 10^{-6}\,\text{m}} = 1.519\ \text{m}^2.$$

(b) The volume of a cylinder of length ℓ is $V = A\ell$ where the cross-section area is that of a circle: $A = \pi r^2$. Therefore, with $r = 2.500 \times 10^{-6}$ m and $V = 1.519 \times 10^{-6}\ \text{m}^3$, we obtain

$$\ell = \frac{V}{\pi r^2} = \frac{1.519\times 10^{-6}\,\text{m}^3}{\pi(2.500\times 10^{-6}\,\text{m})^2} = 7.734\times 10^4\,\text{m} = 77.34\ \text{km}.$$

30. To solve the problem, we note that the first derivative of the function with respect to time gives the rate. Setting the rate to zero gives the time at which an extreme value of the variable mass occurs; here that extreme value is a maximum.

(a) Differentiating $m(t) = 5.00t^{0.8} - 3.00t + 20.00$ with respect to t gives

$$\frac{dm}{dt} = 4.00t^{-0.2} - 3.00.$$

The water mass is the greatest when $dm/dt = 0,$ or at $t = (4.00/3.00)^{1/0.2} = 4.21\,\text{s}.$

(b) At $t = 4.21\,\text{s},$ the water mass is

$$m(t = 4.21\,\text{s}) = 5.00(4.21)^{0.8} - 3.00(4.21) + 20.00 = 23.2\text{ g}.$$

(c) The rate of mass change at $t = 2.00\text{ s}$ is

$$\left.\frac{dm}{dt}\right|_{t=3.00\,\text{s}} = \left[4.00(3.00)^{-0.2} - 3.00\right]\text{g/s} = 0.211\text{ g/s} = 1.27\times10^{-2}\text{ kg/min}.$$

(d) Similarly, the rate of mass change at $t = 5.00\text{ s}$ is

$$\left.\frac{dm}{dt}\right|_{t=5.00\,\text{s}} = \left[4.00(5.00)^{-0.2} - 3.00\right]\text{g/s} = -0.101\text{ g/s} = -6.05\times10^{-3}\text{ kg/min}.$$