12. The number of seconds in a year is 3.156×10^7. This is listed in Appendix D and results from the product

$$(365.25\,\text{day/y})(24\,\text{h/day})(60\,\text{min/h})(60\,\text{s/min})\ .$$

(a) The number of shakes in a second is 10^8; therefore, there are indeed more shakes per second than there are seconds per year.

(b) Denoting the age of the universe as 1 u-day (or 86400 u-sec), then the time during which humans have existed is given by

$$\frac{10^6}{10^{10}} = 10^{-4}\ \text{u-day}\ ,$$

which we may also express as

$$\left(10^{-4}\ \text{u-day}\right)\left(\frac{86400\ \text{u-sec}}{1\ \text{u-day}}\right) = 8.6\ \text{u-sec}\ .$$

25. From the Figure we see that, regarding differences in positions Δx, 212 S is equivalent to 258 W and 180 S is equivalent to 156 Z. Whether or not the origin of the Zelda path coincides with the origins of the other paths is immaterial to consideration of Δx.

(a)

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

(b)

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

34. (a) We find the volume in cubic centimeters

$$(193\,\mathrm{gal})\left(\frac{231\,\mathrm{in}^3}{1\,\mathrm{gal}}\right)\left(\frac{2.54\,\mathrm{cm}}{1\,\mathrm{in}}\right)^3 = 7.31\times10^5\ \mathrm{cm}^3$$

and subtract this from $1\times10^6\ \mathrm{cm}^3$ to obtain $2.69\times10^5\ \mathrm{cm}^3$. The conversion gal $\rightarrow$ in^3 is given in Appendix D (immediately below the table of Volume conversions).

(b) The volume found in part (a) is converted (by dividing by $(100\,\mathrm{cm/m})^3$) to $0.731\ \mathrm{m}^3$, which corresponds to a mass of

$$\left(1000\,\mathrm{kg/m}^3\right)\left(0.731\,\mathrm{m}^2\right) = 731\ \mathrm{kg}$$

using the density given in the problem statement. At a rate of 0.0018 kg/min, this can be filled in

$$\frac{731\,\mathrm{kg}}{0.0018\,\mathrm{kg/min}} = 4.06\times10^5\ \mathrm{min}$$

which we convert to 0.77 y, by dividing by the number of minutes in a year (365 days)(24 h/day)(60 min/h).