40. (a) When θ is measured in radians, it is equal to the arclength s divided by the radius R. For a very large radius circle and small value of θ, such as we deal with in Fig. 1-9, the arc may be approximated as the straight line-segment of length 1 AU. First, we convert $\theta = 1$ arcsecond to radians:

$$(1\,\text{arcsecond})\left(\frac{1\,\text{arcminute}}{60\,\text{arcsecond}}\right)\left(\frac{1^\circ}{60\,\text{arcminute}}\right)\left(\frac{2\pi\,\text{radian}}{360^\circ}\right)$$

which yields $\theta = 4.85 \times 10^{-6}$ rad. Therefore, one parsec is

$$R_\text{o} = \frac{s}{\theta} = \frac{1\text{ AU}}{4.85 \times 10^{-6}} = 2.06 \times 10^5\text{ AU}\ .$$

Now we use this to convert $R = 1$ AU to parsecs:

$$R = (1\,\text{AU})\left(\frac{1\,\text{pc}}{2.06 \times 10^5\,\text{AU}}\right) = 4.9 \times 10^{-6}\text{ pc}\ .$$

(b) Also, since it is straightforward to figure the number of seconds in a year (about 3.16×10^7 s), and (for constant speeds) distance = speed × time, we have

$$1\,\text{ly} = (186{,}000\,\text{mi/s})\left(3.16 \times 10^7\,\text{s}\right) 5.9 \times 10^{12}\text{ mi}$$

which we convert to AU by dividing by 92.6×10^6 (given in the problem statement), obtaining 6.3×10^4 AU. Inverting, the result is $1\,\text{AU} = 1/6.3 \times 10^4 = 1.6 \times 10^{-5}$ ly.

(c) As found in the previous part, $1\,\text{ly} = 5.9 \times 10^{12}\,\text{mi}$.

(d) We now know what one parsec is in AU (denoted above as R_o), and we also know how many miles are in an AU. Thus, one parsec is equivalent to

$$\left(92.9 \times 10^6\,\text{mi/AU}\right)\left(2.06 \times 10^5\,\text{AU}\right) = 1.9 \times 10^{13}\text{ mi}\ .$$