Astr 1010
Problem Set #2, Solutions

1. a)

$$9,169,540,000 = 9.16954 \times 10^9$$

b)

$$0.000007376 = 7.376 \times 10^{-5}$$

2. a)

$$\frac{(3.36 \times 10^6)(6.85 \times 10^{-14})}{(4.60 \times 10^{-8})} = 5.00$$

b)

$$(8.99 \times 10^9)\frac{(1.609 \times 10^{-19})^2}{(4.66 \times 10^{-10})^2} = 1.07 \times 10^{-9}$$

3. a)

$$\begin{aligned} 7.17 \times 10^{13}\,\mathrm{s} &= \left(7.17 \times 10^{13}\,\mathrm{s}\right)\left(\frac{1\,\mathrm{hr}}{3600\,\mathrm{s}}\right)\left(\frac{1\,\mathrm{day}}{24\,\mathrm{hr}}\right)\left(\frac{1\,\mathrm{yr}}{365.25\,\mathrm{day}}\right) \\ &= 2.27 \times 10^6\,\mathrm{yr} \end{aligned}$$

b)

$$4.2\,\mathrm{ly} = (4.2\,\mathrm{ly})\left(\frac{9.46 \times 10^{12}\,\mathrm{km}}{1\,\mathrm{ly}}\right)\left(\frac{1\,\mathrm{mi}}{1.609\,\mathrm{km}}\right) = 2.47 \times 10^{13}\,\mathrm{mi}$$

4.

a) The circumference of the earth's orbit is

$$C = 2\pi R = 2\pi(1.50 \times 10^{11}\,\mathrm{m}) = 9.42 \times 10^{11}\,\mathrm{m}$$

b) The earth travels the distance found in (a) in one year, and one year is 3.156×10^7 s. For regular motion (such as the earth's motion around the sun) the speed is the distance travelled divided by time:

$$v = \frac{C}{t} = \frac{9.41 \times 10^{11}\,\mathrm{m}}{3.156 \times 10^7\,\mathrm{s}} = 2.99 \times 10^4\,\tfrac{\mathrm{m}}{\mathrm{s}}$$

5. It is probably easiest if we convert some units first. The radius of Europa is

$$R = 1569\,\text{km}\left(\frac{10^3\,\text{m}}{1\,\text{km}}\right)\left(\frac{100\,\text{cm}}{1\,\text{m}}\right) = 1.57\times10^8\,\text{cm}$$

and its mass is

$$M = 4.80\times10^{22}\,\text{kg}\left(\frac{10^3\,\text{g}}{1\,\text{kg}}\right) = 4.80\times10^{25}\,\text{g}$$

Europa is spherical so its volume is

$$V = \tfrac{4}{3}\pi R^3 = \tfrac{4}{3}\pi\left(1.57\times10^8\,\text{cm}\right)^3 = 1.62\times10^{25}\,\text{cm}^3$$

Then we find that the (mean) density of Europa is

$$D = \frac{M}{V} = \frac{4.80\times10^{25}\,\text{g}}{1.62\times10^{25}\,\text{cm}^3} = 2.97\tfrac{\text{g}}{\text{cm}^3}$$

This number is significantly greater than the value for water (or Saturn) but significantly less than the density of the earth.

$1\,\text{kg} = 1000\,\text{g}$ $\quad$ $1\,\text{m} = 100\,\text{cm}$ $\quad$ $1\,\text{mile} = 1.609\,\text{km} = 5280\,\text{ft}$

$1\,\text{km} = 1000\,\text{m}$ $\quad$ $1\,\text{ly} = 9.46\times10^{12}\,\text{km}$ $\quad$ $1\,\text{yr} = 3.156\times10^7\,\text{s}$