c) Divide the result of part b by m_{sun} to get

$$\frac{M}{m_{sun}} = \frac{r^* v^{*2}}{G m_{sun}}$$. For the earth sun system

$$m_{earth}\,\omega^2 R = \frac{G\, m_{earth}\, m_{sun}}{R^2}$$ where R = distance from sun to earth

$$\Rightarrow \boxed{\frac{M}{m_{sun}} = \frac{r^* v^{*2}}{\omega^2 R^3}}$$

$r^* = 32.6$ light years

$v^* = 7.65$ km/sec

$R = 500$ light sec, $\omega = \frac{2\pi}{1\,yr} = \frac{2\pi}{60\cdot 60\cdot 24\cdot 365} = 1.992\times10^{-7}$ sec^{-1}

$r^* = 32.6$ light yrs $= 32.6 \times 60\cdot 60\cdot 24\cdot 365 = 1.028\times10^{9}$ light sec

$v^* = 7.65$ km/sec $= \frac{7.65}{3\times10^5} = 2.55\times10^{-5}$ light sec/sec

$$\frac{M}{m_{sun}} = \frac{1.028\times10^{9}\cdot (2.55\times10^{-5})^2}{(1.992\times10^{-7})^2\,(500)^3} = \frac{6.685\times10^{-1}}{4.96\times10^{-6}}$$

$$= 1.35\times10^{5}$$