

PROB. 12-78

$$r_m = 2r_p \quad \text{SHOW} \quad t = \sqrt{\frac{24\pi}{G\rho}}$$

$$v = \frac{D}{t} \Rightarrow t = \frac{D}{v}$$

$$F = \frac{GM_p M_m}{r_m^2}$$

$$F = M a_n, \quad a_n = \frac{v_m^2}{r_m}, \quad F = \frac{M_m v_m^2}{r_m}$$

$$\frac{GM_p M_m}{r_m^2} = \frac{M_m v_m^2}{r_m}$$

$$v_m = \sqrt{\frac{GM_p}{r_m}} = \sqrt{\frac{4\pi}{3} \cdot \frac{G r_p^3 \rho_p}{r_m}}$$

$$D = 2\pi r_m$$

$$t = \frac{2\pi r_m}{\sqrt{\frac{4\pi G r_p^3 \rho_p}{3 r_m}}} = \sqrt{3\pi} \cdot \sqrt{\frac{r_m^3}{G r_p^3 \rho_p}} = \sqrt{3\pi} \cdot \sqrt{\frac{(2r_p)^3}{G r_p^3 \rho_p}}$$

$$t = \sqrt{\frac{24\pi}{G\rho}}$$