$$GPE = -\frac{GM_1M_2}{R}$$

$$dE = \frac{GMdm}{R}$$

$$M = \frac{4}{3}\pi r^3\rho$$

$$dm = (\text{volume})(\text{density}) = \left(4\pi r^2 dr\right)(\rho)$$

$$GPE = -\frac{GMdm}{r}$$

$$GPE = \int_{r=0}^{r=R} -\frac{G\ \left(\frac{4}{3}\pi r^3\rho\right)\ \left(4\pi r^2 dr\rho\right)}{r}$$

$$GPE = -\frac{3}{5}\left(\frac{GM^2}{R}\right)$$

$$GPE = \frac{GM_{\text{Sun}}M_{\text{Moon}}}{R}$$

system is unbound when $KE + GPE = 0$