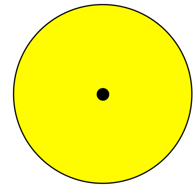
Problem 13.31



When the sun dies, it will collapse down to the size of the earth.

a.) What will its density be?

$$\rho_{whiteDwarf} = \frac{M_{sun}}{\left(\frac{4}{3}\pi R^3{}_{earth}\right)}$$

$$= \frac{\left(1.99\text{x}10^{30}\ \text{kg}\right)}{\left(\frac{4}{3}\pi\left(6.37\text{x}10^{6}\ \text{m}\right)^3\right)}$$

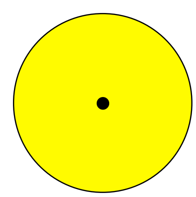
$$= 1.84\text{x}10^{9}\ \text{kg/m}^3$$

b.) What is the surface free fall acceleration?

$$a = \frac{GM_{sun}}{R_e{}^2}$$

$$= \frac{\left(6.67\text{x}10^{-11}\ \text{N}\bullet\text{m}^2/\text{kg}^2\right)\left(1.99\text{x}10^{30}\ \text{kg}\right)}{\left(6.37\text{x}10^{6}\ \text{m}\right)^2}$$

$$= 3.27\text{x}10^{6}\ \text{m/s}^2$$



c.) The potential energy of a 1.00 kg object sitting on the surface of the white dwarf?

$$U(r) = -\frac{GmM}{R_e}$$

$$= -\frac{\left(6.67\text{x}10^{-11}\ \text{N}\bullet\text{m}^2/\text{kg}^2\right)\left(1.00\ \text{kg}\right)\left(1.99\text{x}10^{30}\ \text{kg}\right)}{\left(6.37\text{x}10^{6}\ \text{m}\right)}$$

$$= -2.08\text{x}10^{13}\ \text{J}$$