9.35) IN A NEUTRON STAR, THE ENTIRE STELLAR MASS HAS COLLAPSED TO NUCLEAR DENSITY. FOR A STAR OF 10 KM RADIUS AND 4.50×10^{30} kg, FIND THE FERMI ENERGY OF THE NEUTRONS

FERMI ENERGY: $E_F = \frac{\hbar^2}{8m}\left(\frac{3}{\pi}\frac{N}{L^3}\right)^{2/3}$ (9.42)

- FIND NUMBER OF NEUTRONS IN THE STAR

$m_{n^0} = 1.675 \times 10^{-27}$ kg

$m_\star = N m_{n^0} \Rightarrow N = \frac{m_\star}{m_{n_0}} = \frac{4.50 \times 10^{30}}{1.675 \times 10^{-27}}$

$\Rightarrow N = 2.69 \times 10^{57}$ Wow!

- FIND VOLUME OF THE STAR

$L_\star^3 = \frac{4}{3}\pi\left(10 \times 10^3\right)^3 = 4.19 \times 10^{12}\ m^3$

$\Rightarrow \frac{N}{L^3} = \frac{2.69 \times 10^{57}}{4.19 \times 10^{12}} = 6.42 \times 10^{44}\ \frac{n_0}{m^3}$

THUS

$E_{F,\star} = \frac{(6.63 \times 10^{-34})^2}{8(1.675 \times 10^{-27})}\left[\frac{3}{\pi}(6.42 \times 10^{44})\right]^{2/3}$

$E_{F,\star} = (3.28 \times 10^{-41})(7.21 \times 10^{29})$

$E_{F,\star} = 2.37 \times 10^{-11}\ J\left(\frac{eV}{1.602 \times 10^{-19}\ J}\right)$

$E_{F,\star} = 1.48 \times 10^8\ eV$

$\boxed{E_{F,\star} = 148\ MeV}$ YEAH! HUGE

↳ DUE TO CLOSE PACKING OF NEUTRONS