$$pc = 6.63\times10^{-20} \times 3\times10^{8} = 1.99\times10^{-11}\ \text{J} = 124\ \text{MeV}$$

$$E = \sqrt{(124)^2 - (0.511)^2}\ \text{MeV}$$

$$E = 124\ \text{MeV}$$

$$K = E - m_0c^2 = 124 - 0.511 \simeq 124\ \text{MeV}$$

) According to example 4.11, this kinetic energy is too high. So we would not expect the electron to be confined to a region the size of the nucleus.

b# 17.

$$\omega(k) = \sqrt{c^2k^2 + \left(\frac{m_e c^2}{\hbar}\right)^2}$$

$$v_p = \frac{\omega}{k} = \frac{1}{k}\sqrt{c^2k^2 + \left(\frac{m_e c^2}{\hbar}\right)^2}$$

$$v_g = \frac{d\omega}{dk} = \frac{1}{2}2c^2k\,\frac{1}{\sqrt{c^2k^2 + \left(\frac{m_e c^2}{\hbar}\right)^2}} = \frac{c^2k}{\sqrt{c^2k^2 + \left(\frac{m_e c^2}{\hbar}\right)^2}}$$

$$v_p \times v_g = \frac{1}{k}\sqrt{c^2k^2 + \left(\frac{m_e c^2}{\hbar}\right)^2} \times \frac{c^2k}{\sqrt{c^2k^2 + \left(\frac{m_e c^2}{\hbar}\right)^2}} = c^2.$$

If $v_p > c \Rightarrow \boxed{v_g < c}$