

15. (a) The de Broglie wavelength is given by $\lambda = h/p$, where p is the magnitude of the momentum. The kinetic energy K and momentum are related by Eq. 38-51, which yields

$$pc = \sqrt{K^2 + 2Kmc^2} = \sqrt{(200 \text{ MeV})^2 + 2(200 \text{ MeV})(0.511 \text{ MeV})} = 200.5 \text{ MeV} .$$

Thus,

$$\lambda = \frac{hc}{pc} = \frac{1240 \text{ eV} \cdot \text{nm}}{200.5 \times 10^6 \text{ eV}} = 6.18 \times 10^{-6} \text{ nm} = 6.18 \text{ fm} .$$

- (b) The diameter of a copper nucleus, for example, is about 8.6 fm, just a little larger than the de Broglie wavelength of a 200-MeV electron. To resolve detail, the wavelength should be smaller than the target, ideally a tenth of the diameter or less. 200-MeV electrons are perhaps at the lower limit in energy for useful probes.