4-8. $$b = \frac{kq_\alpha Q}{m_\alpha v^2}\cot\frac{\theta}{2} \quad \text{(Equation 4-3)}$$

$$= \frac{k\cdot 2e\cdot Ze}{m_\alpha v^2}\cot\frac{\theta}{2} = \frac{(1.44\,MeV\cdot fm)Z}{E_{k\alpha}}\cot\frac{\theta}{2}$$

$$= \frac{(1.44\,MeV\cdot fm)(79)}{7.7\,MeV}\cot\frac{2^\circ}{2} = 8.5\times 10^{-13}\,m$$

4-40. Those scattered at $\theta = 180°$ obeyed the Rutherford formula. This is a head-on collision where the α comes instantaneously to rest before reversing direction. At that point its kinetic energy has been converted entirely to electrostatic potential energy, so

$\frac{1}{2}m_\alpha v^2 = 7.7\,MeV = \frac{k(2e)(79e)}{r}$ where r = upper limit of the nuclear radius.

$$r = \frac{k(2)(79)e^2}{7.7\,MeV} = \frac{2(79)(1.440\,MeV\cdot fm)}{7.7\,MeV} = 29.5\,fm$$

4-49. (a) $b = R\sin\beta = R\sin\left(\frac{180° - \theta}{2}\right) = R\cos\frac{\theta}{2}$

(b) Scattering through an angle larger than θ corresponds to an impact parameter smaller than b. Thus, the shot must hit within a circle of radius b and area πb^2. The rate at which this occurs is $I_o\pi b^2 = I_o R^2\cos^2\frac{\theta}{2}$

(c) $\sigma = \pi b_o^2 = \pi\left(R\cos\frac{0}{2}\right)^2 = \pi R^2$

(d) An α particle with an arbitrarily large impact parameter still feels a force and is scattered.