

40. We are concerned with the charges in the nucleus (not the “orbiting” electrons, if there are any). The nucleus of Helium has 2 protons and that of Thorium has 90.

(a) Eq. 22-1 gives

$$F = k \frac{q^2}{r^2} = \frac{\left(8.99 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}\right) (2(1.60 \times 10^{-19} \text{ C})) (90(1.60 \times 10^{-19} \text{ C}))}{(9.0 \times 10^{-15} \text{ m})^2} = 5.1 \times 10^2 \text{ N} .$$

(b) Estimating the helium nucleus mass as that of 4 protons (actually, that of 2 protons and 2 neutrons, but the neutrons have approximately the same mass), Newton’s second law leads to

$$a = \frac{F}{m} = \frac{5.1 \times 10^2 \text{ N}}{4(1.67 \times 10^{-27} \text{ kg})} = 7.7 \times 10^{28} \text{ m/s}^2 .$$