**65.** In the radioactive decay of Eq. 21-13, a $^{238}$U nucleus transforms to $^{234}$Th and an ejected $^{4}$He. (These are nuclei, not atoms, and thus electrons are not involved.) When the separation between $^{234}$Th and $^{4}$He is $9.0\times10^{-15}$ m, what are the magnitudes of (a) the electrostatic force between them and (b) the acceleration of the $^{4}$He particle?

The radioactive decay mentioned is
$^{238}\text{U} \rightarrow {}^{234}\text{Th} + {}^{4}\text{He}$.

$^{234}$Th has 90 protons and $^{4}$He has 2.

Charge of a proton is $e = 1.602\times10^{-19}$.

The electrostatic force between Th and He is thus the electrostatic force between 90 protons and 2 protons.

$$F = k\frac{q_1 q_2}{r^2} = (8.99\times10^9)\frac{(90\times1.602\times10^{-19})(2\times1.602\times10^{-19})}{(9.0\times10^{-15})^2} = 5.1\times10^2\,N$$

Proton mass $m_p = 1.67\times10^{-27}\,kg$.

Neutron mass $m_n = 1.68\times10^{-27}\,kg$.

$^{4}$He has 2 protons and 2 neutrons (we don't take into consideration the electrons as the question tells us that no electrons are involved).

Thus, mass of $^{4}$He particle is

$$m_{He} = 2m_p + 2m_n = 2\times1.67\times10^{-27} + 2\times1.68\times10^{-27} = 6.70\times10^{-27}\,kg$$

$$a_{He} = \frac{F}{m_{He}} = \frac{5.1\times10^2\,N}{6.70\times10^{-27}\,kg} = 7.7\times10^{28}\,\frac{m}{s^2}$$