5. The nucleus of ^{8}Be, which consists of 4 protons and 4 neutrons, is very unstable and spontaneously breaks into two alpha particles (helium nuclei, each consisting of 2 protons and 2 neutrons). *(i)* What is the force between the two alpha particles when they are 5.00×10^{-15} m apart, and *(ii)* what will be the magnitude of the acceleration of the alpha particles due to this force? Note that the mass of an alpha particle is 4.0026 u.

Solution *(i)* Since the charges have opposite signs, the force is repulsive. The magnitude of the force is given by Coulombs law, $F = \frac{1}{4\pi\epsilon_0}\frac{4e^2}{r^2} = 8.99 \times 10^9 \ \frac{\text{Nm}^2}{\text{C}^2}\frac{4(1.6\times10^{-19}\ \text{C})^2}{(5.00\times10^{-15}\ \text{m})^2} = 36.8$ N. *(ii)* The mass of an alpha particle is $m = 4.0026\ u$, where $u = 1.66 \times 10^{-27}$ kg is the unified mass unit. Applying Newton's 2nd law, the acceleration of either alpha particle is then $a = \frac{F}{m} = \frac{36.8\ \text{N}}{4.0026\cdot1.66\times10^{-27}\ \text{kg}} = 5.54 \times 10^{27}\ \text{m/s}^2$. Of course from Newton's 3rd law, both alpha particles experience the same force, and hence undergo the same acceleration.