King Fahd University of Petroleum & Minerals

Physics Department

Phys212- Quiz#2

Name: Key ID#:

1. A radium isotope decays to a radon isotope, ^{222}Rn by emitting an α particle according to the decay scheme $^{226}Ra \rightarrow {}^{222}Rn + {}^{4}He$. The masses of the atoms are 226.02554 u, 222.0175 u and 4.0026 u, respectively. How much energy in **MeV** is released as the result of this decay? 1u = 1.66×10^{-27} kg.

$$\Delta m = 226.02554\,u - 222.0175\,u - 4.0026\,u$$

$$= 5.44 \times 10^{-3}\,u = 5.44 \times 10^{-3}\,u \times \frac{931.5\,MeV/c^2}{1u}$$

$$= 5.067\,MeV/c^2$$

$$E = \Delta m c^2 = 5.067\,\frac{MeV}{c^2} \times c^2 = \boxed{5.067\,MeV}$$

1. A proton has a total energy that is three times its kinetic energy. Find

(a) Its speed

$$E = K + m_0c^2 = \frac{E}{3} + m_0c^2 \Rightarrow E = \frac{3}{2}m_0c^2 = \gamma m_0c^2 \Rightarrow \gamma = \frac{3}{2} = \frac{1}{\sqrt{1 - u^2/c^2}}$$

$$1 - \frac{u^2}{c^2} = \frac{4}{9} \Rightarrow \frac{u^2}{c^2} = \frac{5}{9} \Rightarrow u = \frac{\sqrt{5}}{3}c = \boxed{0.745\,c}$$

(b) Its kinetic energy in **MeV**

$$K = (\gamma - 1)m_0c^2 = \left(\frac{3}{2} - 1\right)m_0c^2 = \frac{1}{2}m_0c^2 = \frac{1}{2} \times 938\,MeV = \boxed{469\,MeV}$$

(c) Its total energy in **MeV**

$$E = \gamma m_0c^2 = \frac{3}{2}m_0c^2 = \frac{3}{2} \times 938\,MeV = \boxed{1407\,MeV}$$

(d) Its momentum

$$p^2c^2 = E^2 - (m_0c^2)^2$$

$$pc = \sqrt{E^2 - (m_0c^2)^2} = \sqrt{1407^2 - 938^2} = 1048.7\,MeV$$

$$\boxed{p = 1048.7\,\frac{MeV}{c}}$$