Question #80165, Physics / Other

In a circular accelerator a proton is accelerated to an energy of 10*12 eV, as measured in the laboratory frame. If the rest energy of the proton is 10*9 eV, calculate

i) the speed of the proton as measured in the laboratory frame

ii) the force that must be applied by the magnets in the accelerator to keep the protons moving at this speed in a circle of radius 1000 m.

Solution

i)

$$E = \frac{E_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$1 - \frac{v^2}{c^2} = \left(\frac{E_0}{E}\right)^2$$

$$v = c\sqrt{1 - \left(\frac{E_0}{E}\right)^2}$$

$$v = 299792458\sqrt{1 - \left(\frac{10^9}{10^{12}}\right)^2} = 299792308\frac{m}{s}$$

ii)

$$F = \frac{mv^2}{r}$$

$$F = \frac{1.672621898 \cdot 10^{-27}}{1000}(299792308)^2 = 1.50 \cdot 10^{-13}N.$$