Answer on Question #42933, Physics, Relativity

During machine testing time, a proton in the Large Hadron Collider travels at 0.999990 c, where c is the velocity of light. a) Find the total energy of the proton. (ANS: 3.36144 x 10-8 J or 0.209804 TeV) b) Find its kinetic energy. (ANS: 3.34641 x 10-8 J or 0.208866 TeV)

Solution

Total energy is relativity is

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

Hence, total energy of proton is

$$E = \frac{938.272\,\text{MeV}}{\sqrt{1 - 0.999990^2}} \approx 209804\text{MeV} = 0.209804\,\text{TeV} = 3.36144 \cdot 10^{-8}\,J$$

The rest energy is

$$E_0 = mc^2$$

Hence, kinetic energy is

$$E_k = E - E_0 = mc^2(\sqrt{1 - v^2/c^2} - 1) = 209804\text{MeV} - 938.272\text{MeV} \approx 0.208866\,\text{TeV}$$